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E D A L

AMERICA'S STAKE IN INTERNATIONAL OIL

MOST of the criticism thus far directed toward the petroleum agreement drafted during the past summer by representatives of Great Britain and the United States and now pending before the Senate has been based upon its possible effects upon the domestic industry of this country. The objections raised by prominent members of the industry and expressed in resolutions adopted by the Independent Petroleum Association of America, the Interstate Compact Commission and other bodies, are based upon apprehension that ratification of the agreement as a treaty might lead to vesting in an international body or in the federal government authority to regulate the production and distribution of petroleum products within the United States to the possible detriment of the industry and to its ability to meet competition.

This is a matter of concern to all members of the industry and it raises questions that undoubtedly will be fully discussed before the Foreign Relations Committee in the hearings that the chairman of the committee has promised to hold. It has been stated that there was no intention on the part of the framers of the agreement to have it apply to internal operations in either country but it is admitted even by its earnest supporters that the language of the document is vague and in need of clarification. Its application can be clearly defined by the Senate through specific limitations and it is improbable that the administration will strongly oppose such qualifying clauses.

Aside from its relation to the domestic oil industry however the United States has a large stake in the main objective of the agreement which is to prepare the way for establishment of a world conference with broad authority over international trade in petroleum products. Almost from the birth of the industry this country has been a principal factor in this trade. In the early days it pioneered the sale and use of kerosene and lubricants around the world and later on it shipped motor fuel even to countries which were large producers of petroleum. The business of some of the larger exporting companies grew to such an extent that they established their own distribution systems in outside countries. By 1900 oil from the United States was supplying almost a quarter of the requirements of the rest of the world. The volume of business continued to rise from year to year and in the period from 1920 to 1940 it reached nearly 200 million barrels yearly with a peak value of over $500,000,000. Petroleum products formed the second largest single group among exports and represented 12 per cent of the total trade of the country.

As their sales attained large proportions American companies, naturally enough, sought to develop production in areas having favorable locations with reference to their various markets. This movement became particularly active in the 1920's when fears of the early exhaustion of home resources were rife in the United States. During the period between the two world wars production outside the United States by American owned oil companies more than doubled and in 1941 amounted to over 600,000 barrels daily or more than one quarter of the world output, exclusive of the United States. American investments in oil properties outside the nation's borders at the beginning of this war were estimated at more than one and a quarter billion dollars.

The large participation of American capital and enterprise in the world oil industry has been of benefit to the United States in several ways. It has enhanced the national income through the return upon this huge investment. It has helped the countries in which American owned oil enterprises are located through the disbursement of great sums for wages and local products. It has made the entire petroleum world acquainted with American built oil industry equipment and helped create a market for hundreds of millions of dollars worth of machinery and supplies.

It is worth noting that this record of American development abroad has been made by the enterprise and risk taking of private individuals and companies without government subsidy or government participation. All that American oil operators have asked for is a fair field and no favors. The State Department of the United States was of decided help in providing that opportunity, particularly in the decade following World War I, by its vigorous insistence upon the policy of the open door and upon equality of treatment for its nationals. Contemplation of this record suggests two obvious conclusions. One is that it is important to the national welfare to preserve the position that Americans have won. The second is that those who have built this structure deserve to be consulted in the framing of any such world organization as has been proposed and to an important share in its administration.

SOVIET DEMANDS MAY PERCIPITATE

New Middle East Controversy

By Eliahu Ben-Horin

ON a day last month the press reported a touching celebration which took place in Teheran, Iran, marking the arrival of the millionth ton of freight delivered by the American railroad moving lend-lease supplies to Russia. "—High officers of the American and Russian armies were on hand; bands played; honor guards saluted; the Diesel locomotive was decked in flags. . ."

Next day, Izvestia, official organ of the Soviet government in Moscow, expressed its indignation at the presence of American troops in Iran, asking how it could happen that a foreign power which had no treaty with sovereign Iran was maintaining armed forces there. The fine celebration of the day before was conveniently ignored, as was the purpose which brought about the presence of American service troops in Iran. Fortunately for Moscow the days of crisis in the Soviet-German War are long over. The Iranian supply route is no more of importance to the defence of the Soviet Union.

Iranian oil, however, and the proper post-war division of spheres of political and economic influence seem to be of such importance to the Kremlin, as to justify a deliberate attack on one of the Allies by a recognized spokesman for another of the coalition in the midst of negotiations for continuing close American-Soviet-British war collaboration into the long years of peace. For this sudden maneuver of Izvestia was preceeded by news of a Soviet bid for an oil concession in northern Iran; a refusal by the Shah's government to grant the concession at the present time; and official British-American statements that the Western Allies raise no objections to the decision of the sovereign Persian government not to grant any oil concessions until after the war.

It seems that now, several months after the excitement over the ill-fated Arabian pipeline project, a new Middle Eastern oil controversy, involving interests and aspirations of the major powers may be in the making. According to figures issued by the Office of the Petroleum Administrator for War in Washington, Iran holds five billion barrels out of an estimated total of 15,500,000,000 barrels of petroleum reserves in the Middle East. A later estimate, however, made by an American oil mission early in 1944 credits the oil potential of the Middle East with a total of 25-27 billion barrels, of which nine billion are ascribed to the Sheikdom of Kuwait, seven billion to Persia, five to Iraq and four to five to Saudi Arabia. In reality geologists admit that because of the very limited extent of scientific surveys in these areas any estimate of their potential production is the veriest guess. Off the record they admit that it may very well amount to 50 billion barrels or more.

Thus far, the history of Persian oil is almost entirely identical with the history of the Anglo-Iranian Oil Company, Ltd., which is the only organization in Iran producing, refining and selling oil. This British concern, in which the British government itself holds a controlling interest, operates only in southwestern Persia, on a large area extending to tide-water on the Persian Gulf. Over forty years ago, a British subject, William Knox d'Arcy, obtained from the Shah of Persia an exclusive concession for the production and exportation of oil and petroleum products all over the Persian Empire, with the exception of the five northern provinces: Ghilan, Azerbaijan, Astrabad, Mazanderan and Khorassan. This concession, covering an area of 500,000 square miles, developed into the Anglo-Persian (now Anglo-Iranian) Oil Company, one of the largest oil concerns in the world and one of the main sources of British oil supply.

The present Persian oil controversy is not concerned with southern Iran and does not affect the area of exploitation of the Anglo-Iranian Oil Company. It is the yet undiscovered oil deposits of the above five northern provinces of Iran that forms the apple of discord between official Soviet aspirations and the policies of the Persian government. In its attack upon Mohammed Maraghei Said, premier of the Shah's government, who was singled out as being responsible for the refusal to grant the Soviet concession, the Soviet press did not mention the fact that the Persian government also turned down British and American offers to take concessions in eastern and southeastern Iran.

The rivalry over predominance in northern Persia, including its oil, has gone on for a long time. It may now be approaching its final stage. In effect Soviet Russia, which itself embraces oil deposits greater perhaps than any other nation, is serving notice upon the world that it will not permit penetration of this area by nationals of any other power. Looked at from the angle of international politics the pressure that is being put upon the Persian government and the insistence upon immediate compliance with its demand appears to be consistent with the policy pursued elsewhere. The Soviet Union, quite clearly, is determined to protect itself by seeing that friendly and "cooperative" governments are established all along its borders and that non-Russian influences are eliminated among its immediate neighbors. It apparently has decided that the time to make this program effective is now and does not intend to await the conclusion of the war for determination of questions directly affecting its own security or to leave these to the decision of any international body that may be set up later. It is probable that this consideration rather than the possible value of undetermined oil resources in northern Iran is the key to the course it has adopted.

During World War I, a Persian landowner and nobleman, Sipaksalar-Azam, obtained a concession for exploration and production of oil in the province of Mezanderan. In 1916 he sold his concession to a Russian subject Khostaria, who, in addition, obtained from the Persian government an exclusive concession for all the remaining northern provinces. It is needless to say that the Czarist government of Russia gave full recognition to that concession and promised to provide it will all necessary official backing and protection.

The Russian revolution provided Persia with the opportunity to annul all Russian concessions and special privileges. This was fully confirmed by the new Bolshevist regime. In 1921, during the idealistic phase of Soviet foreign policy, Russia signed a treaty with Persia, resuming diplomatic relations and renouncing all and any claims and concessions of the Czarist regime. Communist propaganda at the time described concessions in foreign lands as the worst form of capitalistic exploitation of undeveloped, colonial peoples by imperialistic powers.

Mr. Khostaria, who had no such idealistic compunctions, seemed to entertain different views on the subject. He sold his rights to the British. However, the concession was never put into operation. It required the ratification of the Mejlis (Persian Parliament), which was never obtained, either because the Mejlis objected to British penetration into the north, or because the British themselves preferred not to seek the ratification. An American offer to purchase a concession in northern Iran, made by the Sinclair Oil Company in the early twenties, was without result as the Mejlis refused to grant ratification.

Efforts of American oil interests to extend their operations into southeastern Persia thus far have never reached the stage of actual exploitation. Several years ago an American company, the Amiranian Oil Company, obtained exploratory concessions in eastern Persia and Afghanistan. After conducting preliminary surveys they surrendered their rights for the reason, it was stated, that the cost of development and of marketing any oil that might be found made the project commercially uninviting.

Southeastern Persia, a neighbor of British Baluchistan and India, as well as Afghanistan, lies

in the British sphere of economic and political influence. What goes on there is, of course, of concern to the British, who have vital interests in that area and who have policed the waters of the Persian Gulf, suppressed slavery and kept down gun running for more than a century. It is quite likely that in this area the British might not place difficulties in the way of entry of American oil interests. They might even welcome such a development for it would tend to bring America further into the Middle Eastern picture. It would give the United States a share in the responsibility for the Middle East and a stake in the maintenance of stable conditions there while footing half the bill for police and security in the whole area.

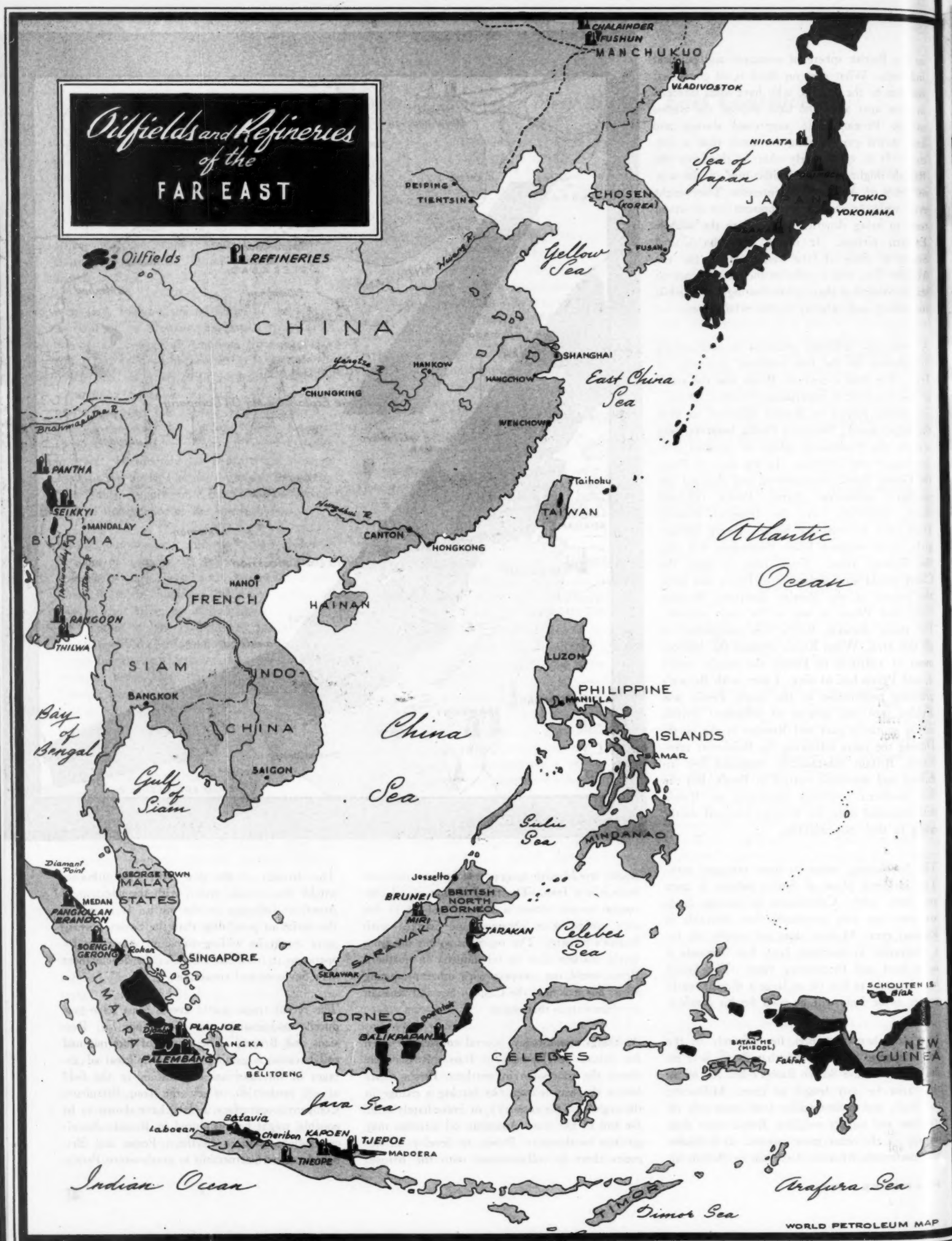
A distinctly different situation is encountered in relation to the five northern provinces of Iran. For over a century, Persia was the arena of Russian-British imperialistic rivalry. At various times, Russia or Britain appeared to gain the upper hand. Northern Persia, however, was always the traditional sphere of Russian predominance and influence. In the days of Peter the Great, Russia overpowered and annexed the northern provinces. Later, Persia regained them. Deserters from the Imperial Russian army used to cross the border, marry Persian girls, often embrace Islam themselves and join the Persian army. From time to time, the Czars would send emissaries to Persia and force the return of the Russian deserters. Russian trade had Persia as one of its main markets. For many decades, Russia was omnipotent in all this area. When Russia opposed the development of railroads in Persia, she simply vetoed it, and Persia had to obey. Later, with Britain's growing penetration in the south, Persia was divided into two spheres of influence: British in the southern part and Russian in the north. During the years following the Bolshevist revolution, Britain substantially expanded her influence and economic control in Persia, but the five northern provinces bordering on Russia still remained open for Russia's eventual awakening to their potentialities.

This awakening seems to have occurred now. The idealistic phase of Soviet policies is gone and done with. Concessions in foreign lands are now not only permissible but desirable in Russian eyes. Moscow does not simply ask for a concession in northern Iran, but demands it in a loud and threatening voice. The Soviet bear is ready to bite off as large a slice of world power as he feels will be good for his comfort.

Iran's northern provinces lie definitely in the Soviet sphere. It is obvious that Persia is in no position to refuse Soviet Russia's bid for oil in that area for any length of time. Militarily, politically and economically, Iran must rely on its close and mighty neighbor Russia more than on any of the other great powers. It is doubtful, moreover, whether American or British interests would wish to oppose a Soviet concession in northern Iran. The truth is that no oil concession to any nation is practical politics in this area, unless it is obtained and worked with Russia's consent. The region is so cut off from world markets that an oil industry in northern Persia could not compete with other producing areas, but it is near the Caspian Sea and Russian developments in that region.

As things stand today, several courses are open for future development in Iran. Russia may obtain the concession in northern Persia either before the war is over (by forcing a change in the regime of the country), or immediately after the end of the war. American oil interests may go into southeastern Persia, to develop oil deposits there in collaboration with the British. The division of the two spheres of influence would thus remain intact, with the addition of American influence in the south. It is within the realm of possibility that the Soviet government might be willing to admit American cooperation in northern Persia in the development of a Soviet-owned concession.

The recent tragic world events must have produced modifications in the minds of Russians and Britons. The course of international collaboration is gaining favor. The great advantages of international cooperation in the field of oil production, which the Iraq Petroleum Company's operations in Iraq have shown to be possible, might be introduced by Russian-American collaboration in northern Persia and British-American partnership in southeastern Persia.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Laboean
Cheribon
KAPOEN
TJEPOE
JAVA
MADOERA
THEOPE
Indian Ocean
Arafura Sea
TIMOR
Timor Sea
WORLD PETROLEUM MAP

Tsurumi Refinery, Kanagawa Prefecture, Japan.

Kashiwazaki Refinery, Niigata Prefecture.

JAPAN FACES LOSS OF ESSENTIAL OIL SUPPLY

WAR in the Pacific is now at the stage where the tactics of attrition can begin to be applied effectively to Japan. The foothold that American troops have gained in the Philippines makes possible the establishment of air fields from which bombing attacks can be made upon the supply line of the Japanese from their home ports to the East Indies and the Malay peninsula from which a great part of their materials of war are drawn. Extension of American lines will make possible the intensification of these attacks to the point of greatly reducing if not entirely stopping the movement of enemy troops and supplies through the China Sea.

Japan has not been able to exploit fully the resources of the areas that her armies have occupied but is dependent upon these territories for many essential materials. Rice, rubber, tin, chrome, vegetable oils and, most important of all, petroleum are all obtained from these occupied areas. In the case of oil no other adequate source of supply is available to the Nipponese. Japan's indigenous production of crude before the war was of the order of 3,000,000 bbl. yearly and it is not believed that this has been materially expanded in the past three years. Special efforts have been directed, however, to the increase of shale oil production in Manchuria and to the building of plants for the manufacture of synthetic petroleum products from coal. Exact figures as to the extent of this development are not obtainable but it is estimated that at the outside the supply from these sources cannot exceed 12,000,000 to 15,000,000 bbl. annually.

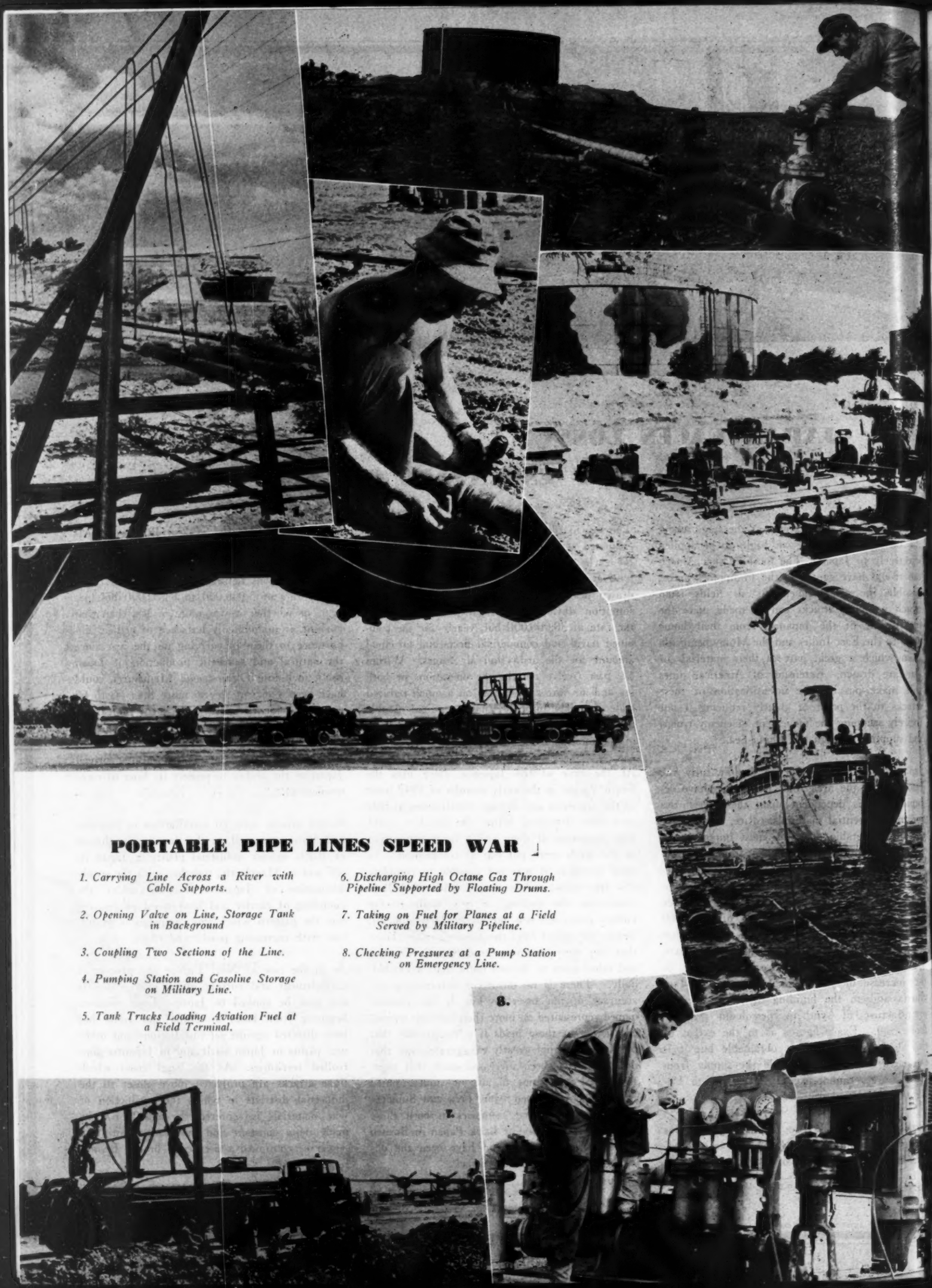
For several years before the war Japan was engaged in building up a large reserve of gasoline and fuel oil for use of its army and navy. The size of this reserve by December 1941 was estimated at 50,000,000 to 60,000,000 bbl. In the earlier stages of the war the country's extensive naval and aerial operations must have drawn heavily upon this supply. Actual consumption during this period probably was at the rate of 30,000,000 bbl. yearly for the combined naval and commercial fleets and an equal amount for the army and air forces. Within the past twelve months the operations of both sea and air forces have been on a much reduced scale but they probably have required double the quantity obtainable within the inner circle of Japanese control.

At the time of the Japanese drive into the South Pacific in the early months of 1942 most of the refineries and storage installations in that area were destroyed before the invaders could gain possession of them and a large proportion of the wells were put out of commission. In some instances it was not possible to complete this destruction and in certain fields of shallow production the drilling of new wells to tap known reservoirs was not particularly difficult. Before the end of 1942 the Japanese made claims that they were obtaining from Brunei, Taraken and other parts of Borneo more than 8,000 bbl. daily. There is no means of determining the accuracy of this assertion but as the quantity named represented no more than half the normal production of those fields it is conceivable that the figure was not greatly exaggerated and that the output has been increased since that time. Additional quantities of oil of undetermined amount were obtained from Java and Sumatra for it is known that refineries in both those islands as well as one at Balik Papan in Borneo have been in operation and have been the objectives of Allied bombing attack.

Whether the quantity of petroleum products drawn by the Nipponese from captured British and Dutch territory was, as has been estimated by some persons familiar with conditions there, at the rate of 5,000,000 to 8,000,000 bbl. per year, or whether it was more or less than that amount, it undoubtedly has been of critical importance to them in carrying on the war since the natural and synthetic production of Japan itself, including Formosa and Manchuria, could have been sufficient for no more than 50 to 60 percent of requirements. The heavy defeat inflicted on Japanese naval and air forces in the recent battle of the Philippines has reduced these requirements but it has also deprived Japan of the ability to protect its lines of communication.

Recent attacks upon oil installations in Sumatra and Borneo as well as the devastating thrusts of B-29s against industrial plants in Japan itself and in Manchuria, together with the steady decimation of Japanese shipping under the pounding of carrier and land based planes, define the pattern which this campaign is to follow with increasing power and effect.

As in the case of Nazi Europe the process of encirclement and cutting off of war materials can now be applied to Japan. Long distance bombing from bases in China and India has been directed against oil installations and other war plants in Japan itself and in Japanese controlled territories. As the bases from which these attacks are projected move closer to the industrial districts in which the production of war materials is centered the assault can be made more constant and devastating until the power of continued resistance is broken beyond repair.



PORTABLE PIPE LINES SPEED WAR

1. Carrying Line Across a River with Cable Supports.

2. Opening Valve on Line, Storage Tank in Background

3. Coupling Two Sections of the Line.

4. Pumping Station and Gasoline Storage on Military Line.

5. Tank Trucks Loading Aviation Fuel at a Field Terminal.

6. Discharging High Octane Gas Through Pipeline Supported by Floating Drums.

7. Taking on Fuel for Planes at a Field Served by Military Pipeline.

8. Checking Pressures at a Pump Station on Emergency Line.

MILITARY PIPE LINES PROVE THEIR WORTH

Engineers Estimate That Portable Line Across France, Laid in Record Time, Pays for Itself Every Twelve Days. $100,000,000 Spent by Army on its Pipe Line Equipment.

Washington

GENERAL Patton's sudden break-through in Normandy and his dash across France gave the portable military pipe line its first real workout and established it as an ace means of transporting petroleum products efficiently and economically under rapidly moving combat conditions. The pipe line fulfilled all the expectations of the Army Engineer Corps, which fought for the idea when few people realized its value.

Engineers gave the portable pipe line a thorough testing out in the North African, Sicilian and Italian campaigns, and it was on a basis of the lessons learned there that they planned its use in the push across France following D-day. In North Africa a 4-inch pipe was used, and the results led to the plan for the 6-inch invasion pipe in France.

The design of the pipe originated with Sydney S. (Syd) Smith manager of the products pipe line department of Shell Oil Company and it was adopted by the Army after extensive tests just prior to the African invasion. Built of light gauge steel, spirally constructed in 20 foot sections weighing less than 100 pounds and with couplings that can be attached in a matter of seconds the pipe is thoroughly well adapted to the requirements of military use. One mile of it with necessary accessories, pumps, valves, and such weighs about 13 tons, and one Army truck and crew can easily handle a thousand feet of the pipe. One big advantage of the military pipe line is that it is flexible. No excavation is required and it can be laid almost as the "crow flies." Hills, swamps, ditches, rivers, forests and other natural obstacles fail to hinder its progress, and it is so inconspicuous that it is almost impossible to detect from the air. The complete line can be laid at a speed of about 10 miles a day over average terrain.

One of the outstanding feats of the petroleum division of the Engineers has been in carrying the Army pipe line across France. When the breakthrough came and General Patton's motorized forces set off on their thrilling dash eastward the pipe line gang took after them. Obviously they could move no faster than construction materials came forward so they could not match the speed of the tanks but they set up some new pipe laying records and the way in which the line was shoved across the country will be something for the boys to reminisce about in days to come.

In the cross-Channel invasion men of the Engineer Petroleum Division landed at the Normandy beach-head D-plus-3, in other words June 9. Their job was to construct the "minor system" of 4-inch pipe lines from the invasion beaches to supply the rear area fighting forces until a major system could be established to extend out of Cherbourg. This "minor system" is still in operation.

Latest figure to be revealed on the mileage of pipe line laid by U. S. Engineers in France is 800 miles, including the "minor system" at the beaches. Three 6-inch lines constitute the major system extending toward Paris. Two of the lines carry motor fuel, the third aviation gasoline. The number of miles of single pipe line in the network is not available.

When these pipe lines were originally designed it was expected that they might be built within twenty miles of the front lines. However, in Normandy Engineer troops built them virtually within sight of the enemy. One Lieutenant and his men were busy laying pipe within five miles of a certain town which was to be the terminus of the line. Despite snipers, artillery fire, and hundreds of enemy mines that had to be lifted, the Lieutenant was making good progress until he met some U. S. infantrymen who asked him where he thought he was going with his pipe lines. "Into the town," he said, indicating the direction of the front. They gave him the ha-ha and told him he'd better sit down and wait until they had captured the town.

In Italy, it is revealed, the lines have been maintained as close as within six to eight miles of the front. As the battle lines in western Europe become more clearly defined and supply priorities permit, it is logical to suppose that the same conditions will prevail.

Although 10 miles a day was considered a good average over ordinary terrain, in France the liners made as much as 50 miles under the pressure of keeping up with the rapid sweep.

Once out of Normandy the greatest problem in laying the line was that of determining the direction it should take. Neither the advance survey teams nor the pipe line crews had much difficulty with terrain in such country as is to be found in northern France. But they did have other problems. When placed along a roadside the pipes were all-too-often crushed by drivers fighting heavy traffic and blackouts. In open field, where they were much less vulnerable to traffic hazards, the pipe faced the dangers created by tanks on cross country runs. Crossings of highways, rivers and railroads created their own hazards. Pipe had to be placed in deep trenches under roads and railroads. To cross rivers the crews had their own suspension lines—usually. Otherwise, they were forced to throw up temporary light trestle bridges.

Indications, but no facts, on sabotage have been reported. However, the same result has been achieved by the natives, whose strong curiosity too often leads to actual damage. Similar reports are received wherever pipe lines are used. The lines are patrolled by pipe line personnel except in the more dangerous areas where other troops may be assigned to watch every foot of the lines.

The tremendous scale of operations in Western Europe required the use of 6-inch parallel pipe lines. This size is used in all main lines and 4-inch in the branch lines, including most of the "minor" or beach-invasion systems. More than a million and a half gallons of fuel have been dispensed through pipe lines in one day of operation in Normandy.

Ninety percent of all motor fuel delivered to the American armies in northern France was supplied, directly or indirectly, through the military pipe lines. The importance of this is more evident when it is known that approximately fifty percent of all supplies moved forward is of bulk fuel. The other ten percent must be taken directly from the port of supply.

With few exceptions all deliveries of fuel are made from the pipe line dispensing points to the battle fields by either tank or cargo truck. Both trucks are used to carry gasoline to airfields and to the ground forces. The great bulk is delivered by tank trucks and by cargo trucks carrying five-gallon "blitz" cans. The drivers of these trucks must bridge gaps between the pipe line and the wandering combat units. That distance may be two miles or 200 miles.

When more gasoline was needed at the front than could be provided by pipe line alone it became necessary to transport it directly from port storage areas. This job usually falls to the transportation corps. However, as General Patton slashed his way across France the enemy often closed the gap behind his forces. When trucks hauling supplies could not reach him the Air Forces sent out their C-47 transports or medium bombers to drop fuel, food, and ammunition. Encased in shockproof, padded, metal containers and dropped by parachute these supplies were delivered to advanced positions in much the same style as to Merrill's Marauders in Burma. At times, gasoline was so desperately

(Continued on page 73)

"Photos Courtesy Producers Monthly"

Left: Air and Gas Lines in Central Pennsylvania Field.

Air Repressuring Cooling System.

OIL RECOVERY BY AIR AND GAS PRESSURE

THE Bureau of Mines[1] estimates that there are 6,364,021,000 barrels of Pennsylvania grade crude oil remaining in low-pressure Appalachian reservoirs. Of this amount 927,856,000 barrels are considered recoverable. Production in this area in 1943 was 25,843,000 barrels, or an average of 70,803 barrels a day. If this rate of production were kept up, the Appalachian fields as they are now known could be exhausted in 34 years, but the fact is that the 1943 rate of production cannot be maintained for that length of time unless secondary-recovery operations are greatly extended, and unless additional wells are drilled in those areas that are only partly developed.

The Bureau of Mines has assigned two reasons why secondary-recovery operations in Appalachia should be extended. One is that the country at war needs Pennsylvania oil. The other is that if refineries in the Appalachian region are to be provided with enough Pennsylvania Grade oil for capacity operation the thousands of operators of small properties who control the majority of the producing acreage in the area must make every effort to increase the production of oil to the desired rate, which is specified as 20,000 barrels a day more than is now being produced. Lately, a third reason has been advanced: the discovery rate of new oil fields has shown a falling off during the period 1940-1944. If the finding of new oil continues to decline at this rate, "second crop" oil produced from stripper fields (or imported oil) will have to be relied on to furnish the major part of the oil needed by the Nation.

[1] *Wartime application of air-gas injection and oil-well reconditioning in the Appalachian region. Bur. Mines R. I. 3777, Sept. 1944.*

Many of the small operators in Appalachia own a few wells producing small quantities of oil a day. Many of them are anxious to increase their production rates by stimulative means, and to rehabilitate their wells so that they will produce more oil to help win the war; but, in general, they are unfamiliar with secondary recovery operations and cannot afford to hire technical assistance.

Why it is necessary to apply stimulative methods to extract the recoverable oil still in the Appalachian pools is explained as follows. In this region the pressure of natural gas has been the principal force that drives the oil out of the sands into the wells, and the volume of gas that comes out with a unit volume of oil is usually greater than the volume of gas associated with a unit of oil remaining in the reservoir. In other words, the amount of gas that remains to push the oil to the pump in the well becomes less and less, and its pressure falls, until finally the rate at which the oil comes to the pump is very slow. Then, if the wells are to continue to produce at profitable rates some means must be found to stimulate the flow of oil into them.

There are two principal means used in the Appalachian area to increase the production of oil wells that have about ceased to drain. One of those is flooding of the oil formation with water; this method has been extensively developed in the Bradford district. In this operation water is pumped into the sand to drive the oil to the well, and where the conditions are just right and the operators can command the necessary funds, water flooding is a very effective means of secondary recovery. The other method which has come into long use is the injection of air or gas into the partially depleted reservoir; this has also been found effective in driving oil to the pump.

The Bureau of Mines has taken the position that an increase in the production of oil from partly depleted fields for war use requires prompt action and the selection of stimulative methods that can be put into operation quickly under wartime conditions. Selected methods should include relatively simple development programs requiring little or no drilling of wells, a minimum of additional equipment, and practical operation with a minimum personnel. The method of production, though on a simple scale during the war, should not create conditions in the reservoir that will prevent more intensive and better engineered development of the property after the war.

Gas-Injection vs. Water-Flooding Methods

As the wartime need for oil is urgent and projects to be intensively developed probably cannot be completed in time to be of material aid, the following discussion is given to show the advantage of gas injection over water flooding as a method for rapidly increasing oil production rates in new areas under wartime conditions. Water-flooding methods should be used only after exhaustive studies of oil properties (including core analyses and other investigations of reservoir characteristics). Experience shows that properly conducted water floods will leave a minimum of recoverable oil in the reservoir, and yield a maximum return of money invested in the enterprise when the property is abandoned. Water cannot be injected indiscriminately into a reservoir, however, through one or a few wells for an extended period of time without affecting adversely the ultimate recovery of oil from the reservoir; in the water displacement of some of the oil, the sand becomes saturated mainly with water, making it virtually impossible to recover additional oil economically later by any known method.

Compressor Plant Interior.

Conversely, gas or air can be injected haphazardly without incurring comparable ultimate loss of reservoir oil, because gas passing from injection to producing wells merely carries oil along mechanically, leaving the sand partly saturated with oil and in condition to make intensive exploiting of the property by water flooding or gas injection a paying operation when normal times return.

Interpretations of laboratory findings resulting from studies of oil formation cores that have known oil and water saturations, indicate that sand containing approximately equal volumes of oil and water (with remaining voids filled with gas), probably cannot be water-flooded successfully. In other words, for a water-flooding project to be successful, more than half of the total liquid saturation of the sand must be oil. If the total saturation (oil and water) is high enough, the greater the ratio of oil to water in the sand the higher the expected oil recovery in water-flooding operations. At Bradford, when the water saturation of the sand is 40 percent or higher, no "bank" of oil will form ahead of the injected water in the reservoir, and if the oil does not bank the water-drive operation is unprofitable.

The laboratory findings also indicate that the injection of gas into most reservoir sands will result in the recovery of additional oil when oil saturations range down to about 25 percent and the sands contain 25 to 60 percent water, with the remaining voids filled with gas; when water saturations exceed 70 percent, the cost of lifting the produced water is excessive; if the sands contain negligible quantities of water, they must contain 40 percent or more oil, otherwise the injection of gas:oil ratio is so high that the volume of oil produced does not warrant the cost of compressing the injected gas; when oil saturations are as low as 20 percent, the sands might be exploited profitably if water saturations are approximately 45 percent.

These laboratory findings are an argument in favor of gas-injection operations in those areas of the Appalachian region where the water saturation of sands is high. As water saturations in some Venango sands of Pennsylvania range from 40 to 60 percent and oil saturations from 25 to 35 percent, these sands cannot be economically water-flooded, *but they can be exploited successfully by gas-injection methods.* It is very important, therefore, that operators recognize the possibility that gas-injection operations may be successful in sands of relatively low oil saturation, precisely because of comparatively high water saturation. In fact, air-injection operations in general have been profitable on several properties where attempts to water flood Venango sands have been unsuccessful.

Air vs. Natural Gas as Injection Medium

Natural gas, when available in sufficient volumes and at low cost, is preferable to air as an injection medium in gas-injection projects. Because needed quantities of gas are not available at low cost in the Appalachian region and the demand for natural gas for fuel purposes seasonally exceeds the combined productive capacities of wells, most operators of small gas-injection projects must use air instead of natural gas in secondary oil-recovery operations.

Although air is a cheap and convenient injection medium in secondary-recovery operations, its use is attended with several disadvantages which, however, can be overcome by taking certain precautions. An air-gas mixture produced with the oil gradually decreases in fuel value, sometimes to the extent that it can no longer be used as fuel for engines. If the air-gas mixture produced with the oil is cycled, as it usually is, explosive mixtures result that are hazardous to life and equipment unless properly handled. Because air or air-gas mixtures, contain oxygen, some corrosion of steel equipment will occur, mainly in the producing wells when small amounts of water are produced with the oil. Air used as the injection medium also tends to oxidize crude oils, but laboratory experiments and field observations indicate that the degree of oxidation of a paraffin-base crude such as Pennsylvania Grade oil is not serious.

The only way to determine if the injection of air will increase the rate of oil production on a property or group of properties in untried areas is to make field tests. The more information that can be obtained on the reservoir conditions, and the wells and equipment, the easier it is to determine the economic probabilities and best plan for development and operation of a property. Nevertheless, regardless of how much information is available, it is good engineering to make adequate field tests, especially in reservoirs that have not been tested. Obviously, for any secondary-recovery project to be successful, the reservoir must contain enough recoverable oil to pay the costs of development and operation. Most reservoirs in the Appalachian region contain enough oil that can be recovered by simple air-injection operations to pay off the comparatively small investment required to equip and operate them. Experience has shown that properties that initially produced large volumes of oil usually respond more favorably to gas or air injection than those initially less productive.

Selection and Preparation of Injection Wells

Because wartime conditions make it difficult to obtain men and equipment for drilling new wells, the selection of injection wells generally is limited to wells already drilled. In selecting producing wells to convert into injection wells, the characteristics of the reservoir and its fluids, and the density of wells penetrating the oil sand, are the most influential factors. The porosity, permeability, saturation, and dip of the oil-bearing formations are the most important factors in selecting the injection wells. Some operators select injection wells that penetrate low-permeability ("tight") sands because usually they contain the most oil after primary depletion; others select injection wells in high-permeability ("loose") sands, because a lower pressure is required to inject air through them into the reservoir sands, and oil remaining in loose sands can be moved to producing wells in less time and at a lower cost per barrel than in tight sands. Wells of high initial productiveness usually are in loose sands, and those producing small flows initially are in less permeable sands. As the permeability of oil sands cannot be ascertained except by drilling wells and analyzing cores from them, producing wells that initially yielded oil at more than average rates (indicating a high permeability oil sand) should be selected as injection wells.

Injection wells should introduce the injected air into the oil sand low on the flank of the structure. However, in the Appalachian region, the location of injection wells with respect to structure is not so important because the dip of the sands is not great. Another factor that should be considered in selecting injection wells is the uniformity of their spacing. The distance between injection and producing wells is not so important as greatly differing distances between them. For example, it would not be wise to select as an injection well one having the nearest producing well 200 feet distant and others 500 to 1,000 feet away, because too much of the energy applied to the injection well would be exerted toward the nearest producing well.

In selecting oil wells for use as injection wells, their current rates of oil production should be considered, because the best producing wells on the property might be found to be best-suited for injecting air into the reservoir. Seldom, however, will it be necessary to use the best producing wells for injection purposes, but so long as oil is needed urgently for war, any slight advantage of the injection-well locations may be sacrificed to maintain high oil-production rates at as many wells as possible. On the other hand, nonproductive wells, even though they are situated in logical locations for introducing air into reservoir sands, seldom make good injection wells.

When converting oil wells into air-injection wells, they should be thoroughly cleaned of

Left: Air Injection Hookup. *Clark Compressors Ready for Installation.*

paraffin, cavings, and other substances that tend to retard free movement of the injection medium into the pay section of the sand. Many oil wells in the Appalachian region are cased only to shallow depths, and much of the hole is "open." Injection wells should be cased or tubed to the top of the oil-pay and cemented or packed off so that air cannot escape into thief sands or to the surface. A depleted gas-cap sand should be packed off, or much of the injected air may bypass through the more permeable part of the sand to the producing wells without doing useful work.

In packing off thief gas sands in old wells, it often is difficult to determine the proper depth at which to set packers or cement the pipe. In the absence of core-analysis data that would indicate the proper place to set pipe, electric-log surveys of the wells are helpful. If electric-log data are not available and there are no accurate driller's logs of the wells, the only way to determine the proper depth for packing off or cementing the pipe is by trial and error. If the proper location for the packers is determined to be in hole that is too large to set pipe with a packer, a cement bridge can be used.

Some air or gas-injection projects have been operated successfully without any initial preparation of the injection wells other than to clean them. On nonintensive-type air-injection projects it is advisable to make preliminary air-injection tests to prove the feasibility of the operation before attempting a well-repair program.

Injection-Well Volumes and Pressures, and Plant Capacity

The optimum initial rate of injection of air into a well cannot be computed with any degree of accuracy, but experience affords a rule-of-thumb method that can be modified to fit known conditions after field tests show the capacity of the wells to take air. The higher the injection rate the more oil that will move through the sand to the producing wells, provided there is no bypassing of oil sand by air. The rate of injection, however, is restricted in part by the pressure limitations of the equipment supplying air to the well. The pressure required to inject air depends upon the resistance of the sand and its contents (oil, water, and gas) to the passage of the air from the injection to the producing wells. Occasionally the thickness of the overburden (overlying rocks) is a factor limiting the use of high pressures, as the safe maximum pressure to use is approximately a gas pressure at the wellhead equal to 1.5 pounds per square inch for each foot of depth of the well. Plant capacity should be determined only after completion of field tests of the injection wells; it should handle the aggregate volume of air to be injected into all wells at the maximum determined wellhead pressure.

In air-injection projects the only way to determine volumes, pressures and required plant capacities is by field tests. Testing an injection well (thoroughly cleaned) will readily show how great a pressure is required to inject air at the selected rate. If, for example, it is decided to inject 50,000 cubic feet of air a day (measured at atmospheric pressure and 60°F. temperature) into a well, testing for a few days ordinarily will indicate how high a pressure will be required to inject that volume. Gradually increasing the pressure will cause air to "break through" in wells and permit increased volumes of air to enter the sand. This "break through" or threshold pressure is that pressure necessary to force gas into the sand at a rate that will start the flow of oil and water through the sand toward producing wells. If the sand is tight (low permeability), the pressure necessary to inject 50,000 cubic feet of air a day may be too high for safe operation of the testing equipment, for economical operation of a permanent compressor plant, or for the overburden to withstand.

On the other hand, the 50,000 cubic feet of air a day may enter the sand at a very low pressure, indicating a loose (high-permeability) sand, low liquid (oil and water) saturation, bypassing of the injected air into a stratum originally containing gas, or channeling of air through a portion of the pay sand almost completely depleted of oil and water. If the selected volume of air enters the sand at a very low injection pressure, continued injection of air until there is an increase in oil production or the gas: oil ratio becomes excessive, will give an idea of the probable path of movement of the injected air through the reservoir.

From experience, in different localities, a rule-of-thumb method has resulted by which it is possible to estimate approximately the rate of initial air injection in field-testing of injection wells by considering only the thickness of the exposed sand in the open hole of the well. After arbitrarily choosing a volume of air to inject daily into a particular injection well, the well is tested to determine if the selected volume can be injected into the sand at an economic pressure through existing pipe lines and equipment. Some operators' estimates of the volumes of air to inject daily range from 300 to 2,000 cubic feet of air per vertical foot of sand exposed in the injection well. In the Appalachian region, where the oil sands are relatively tight, the lower limit of the selected initial volumes is usually about 800 cubic feet of gas or air a day per foot of exposed formations in the well. Thus, if 30 feet of sand is exposed in the injection well, up to 60,000 cubic feet of air a day would be the initial injection rate.

Although it is relatively inexpensive to inject air into partly depleted oil reservoirs, injecting excessive volumes of air (because some of it channels through the sand) may raise the cost above the income derived from the sale of gained oil. The measure of success and the relative cost of an air-injection operation is shown by

the number of cubic feet of air injected per barrel of oil produced—usually termed injection gas: oil ratio.

Produced-gas: oil ratios are more indicative of the effectiveness of air-injection operations than injection-gas: oil ratios because they indicate the directional movement of the injected air and the amount of useful work that has been done by the air in moving oil. Also if the produced-gas: oil ratios are excessively high, the need for remedial work on injection wells is indicated.

Operating Results

Bureau of Mines engineers have made engineering studies of several gas-injection projects on five projects in the Eastern States from which oil is produced from depths ranging from 700 to 3,300 feet. Of the five projects, four are operated on a simplified scale. These four projects use natural gas produced with the oil, augmented by gas obtained from other producing wells in the general vicinity. On the other project enough natural gas was purchased to establish the injection cycle; that is, enough gas was injected to fill the voids in the sand, and the gradually increasing volume of produced gas passing through the sand from injection to producing wells was great enough to cycle at the desired injection rate. Thereafter air was introduced into the cycle to replace the liquids removed from the reservoir and the gas or air-gas mixture consumed as fuel.

With one exception, all of the projects could have produced more oil in less time if more gas, or air in lieu of gas, or more injection wells, or both, had been used. On the five projects, one injection well on the average is used for every 13.2 producing wells. During the first complete year of operation of the five projects, gas was injected into the respective reservoirs at an average daily rate per injection well, ranging from 844 to 6,140 cubic feet per foot of formation exposed in the open holes; in all but one of the projects the average per well injection rate ranged from 844 to 1,759 cubic feet of gas a day per foot of exposed sand.

On the two projects having the lowest and highest injection rate of gas per vertical foot of sand exposed, the injection gas: oil ratios amounted to 3,781 and 5,210, respectively, during the first year of operation. After being operated 11 and 15 years, respectively, the same two projects still exhibit the lowest and highest injection rates (709 and 13,138 cubic feet a day per well per foot of exposed sand, respectively).

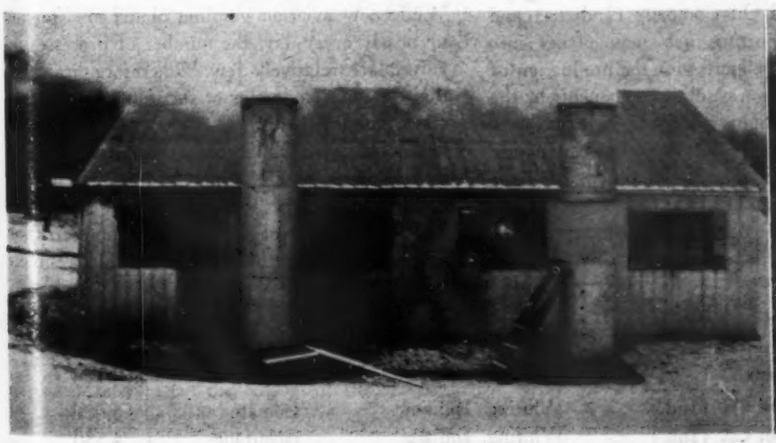
On four of the projects the average per-foot-of-sand injection rates have not changed materially during the intervening years. In some of the projects the average per-foot-of-sand injection rate has declined either because less gas was injected, or different injection wells having more sand thickness have been put into use. The pressure has varied greatly from well to well in most of the projects. On one of the projects gas was introduced into one well for a short time at a pressure of approximately 210 pounds per square inch, whereas the pressure on the other 33 injection wells on the same project rarely was above 35 pounds per square inch. On another project, ultimately including 23 injection wells, pressures as high as 350 pounds per square inch were used, but most of the gas was injected into most of the wells at pressures below 100 pounds per square inch. On this project packers were used in the wells to separate tight and loose strata in the pay section, and the higher pressures were used to inject gas into the tight strata. The average well density for each of the five projects now ranges from 1.55 to 21.30 (average 13.9) acres per well.

Despite the low ratio of injection to producing wells and the relatively small volume of gas that have been injected into the reservoirs, four of these projects, involving 603 oil wells, have yielded approximately 1,115,000 barrels of oil more than would have been produced if there had been no injection of gas to stimulate the production of oil. This quantity of gained oil has been recovered since the projects were initiated 8 to 15 years ago on properties some of which would have been abandoned years ago if injection had not made oil-producing operations profitable.

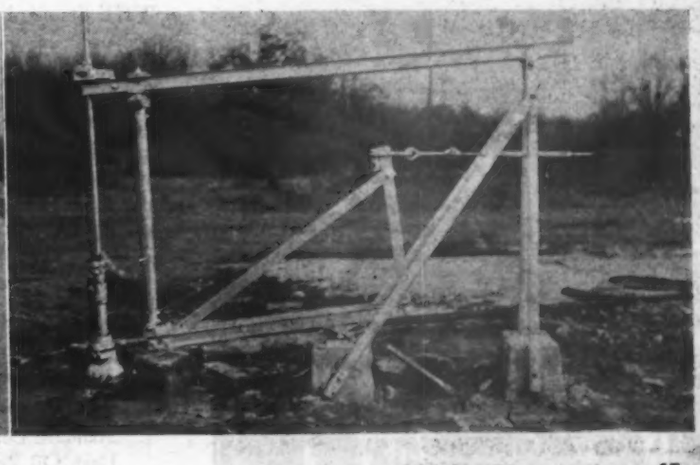
By "breaking down" the figure for total gained oil to a per-well-per-day basis for each project the relative success of each gas-injection operation is evident. During the 9 years of operation of the project producing the least amount of gained oil per well, the over-all average daily rate of production per well was 0.87 barrel of oil, whereas it is estimated that if no gas has been injected into the reservoir only 0.49 barrel of oil a day per well would have been recovered. Therefore, the gain in recovery as a result of gas-injection operations was 78 percent. For the project producing the greatest amount of gained oil per well, the 15-year over-all average daily rate of production per well as the result of the injection of gas was 1.68 barrels; if no gas had been injected, only 0.17 barrel of oil a day per well would have been recovered. The gain in production was 888 percent. The project that produced oil at the greatest over-all average rate is the one cited as having been operated under extremely high gas-injection rates.

During the last year for which data are available, wells on the project that yielded oil at the least over-all average rate have produced at an average rate of 0.79 barrel of oil a day, and on the project that yielded oil at the greatest over-all average rate, the last year's production rate per well was 1.17 barrels a day. Each of the other two projects have operated for 8 years, and the over-all average daily production of oil per well on one of them was 0.62 barrel under gas injection. As the production would have been about 0.24 barrel a day per well if no gas had been injected, the increase in oil recovered amounted to 158 percent. For the other project the same over-all 9-year average per well rates respectively amounted to 0.94 and 0.25 barrel—a gain of 276 percent. During the last year for which data are available, each well on these two projects produced an average of 0.60 and 0.91 barrel of oil a day respectively.

Air and Gas Repressuring Plant Showing Exhausts.



Pumping Jack and Central Power.

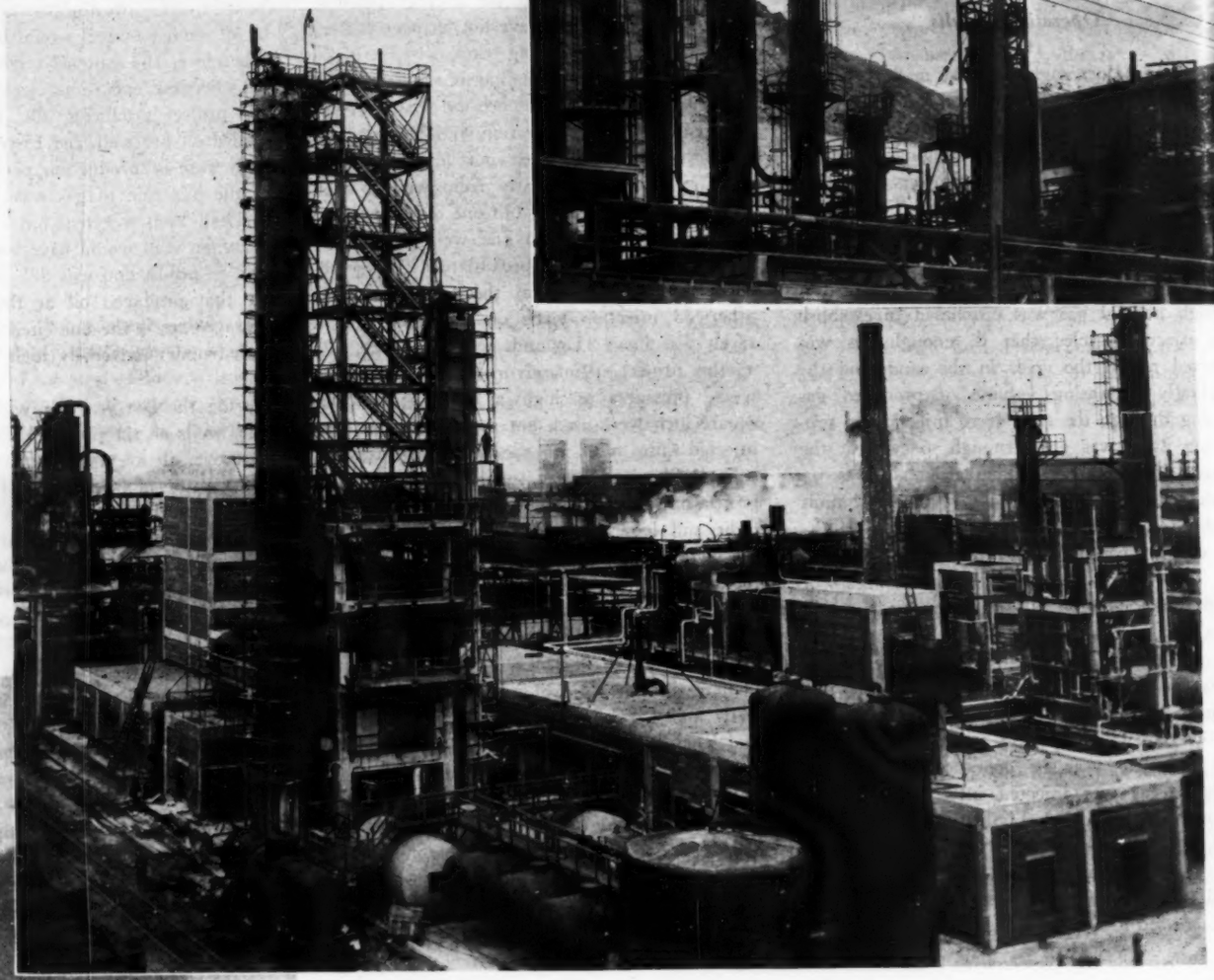


COMMERCIAL ISOMERIZATION OF LIGHT PARAFFINS

D. L. Evering, N. Fragen and G. S. Weems

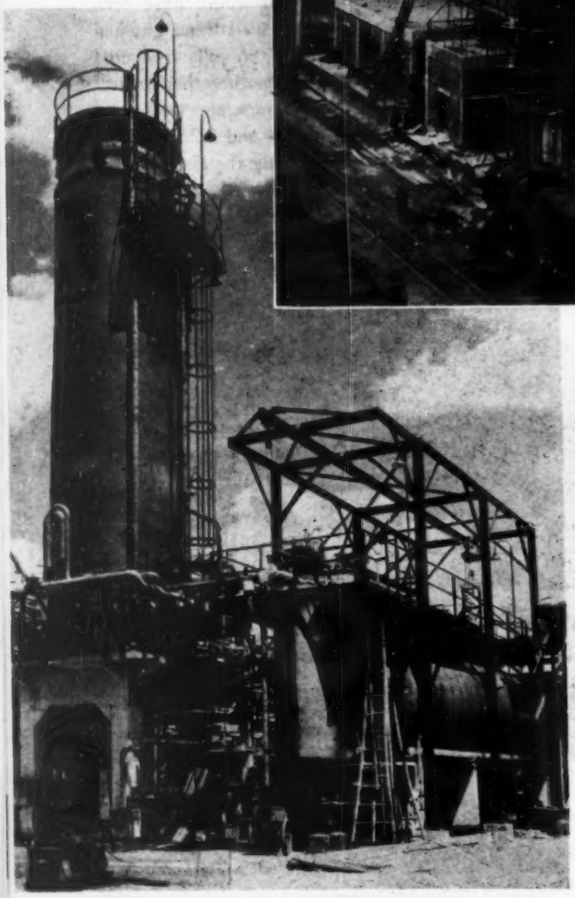
Standard Oil Company (Indiana), Whiting, Indiana

Upper Right: Fractionation Towers of the Utah Neohexane Unit.



Right: General View of Whiting Isomate Unit.

Below: Wood River Butane Isomerization Reactor.



THE Standard Oil Company (Indiana) and subsidiaries are putting five new plants into operation at their refineries for the production of isobutane and aviation gasoline components by the isomerization of light paraffinic hydrocarbons. These plants, listed below, employ three separate new processes for the isomerization of light naphtha, pentane and butane, all of which are integrated with the current 100 octane number aviation gasoline production at these refineries.

While new aviation gasoline plants are starting up nearly every day, the number of processes involved are relatively few. Therefore, it is felt that the novel character of the isomerization processes employed in the above plants warrants such description as Secrecy Orders, censorship, and regulations will permit.

The development of new catalytic isomerization techniques has not only made possible a simple

Company	Refinery Location	Type	Bbl./Day
Standard Oil Co. (Ind.)	Whiting, Indiana	Isomate	5,000
Standard Oil Co. (Ind.)	Whiting, Indiana	Isobutane	4,530
Utah Oil Refining Co.	Salt Lake City, Utah	Neohexane	1,750
Standard Oil Co. (Ind.)	Wood River, Illinois	Isobutane	4,250
Pan American Refining Corp.	Texas City, Texas	Isopentane	1,620

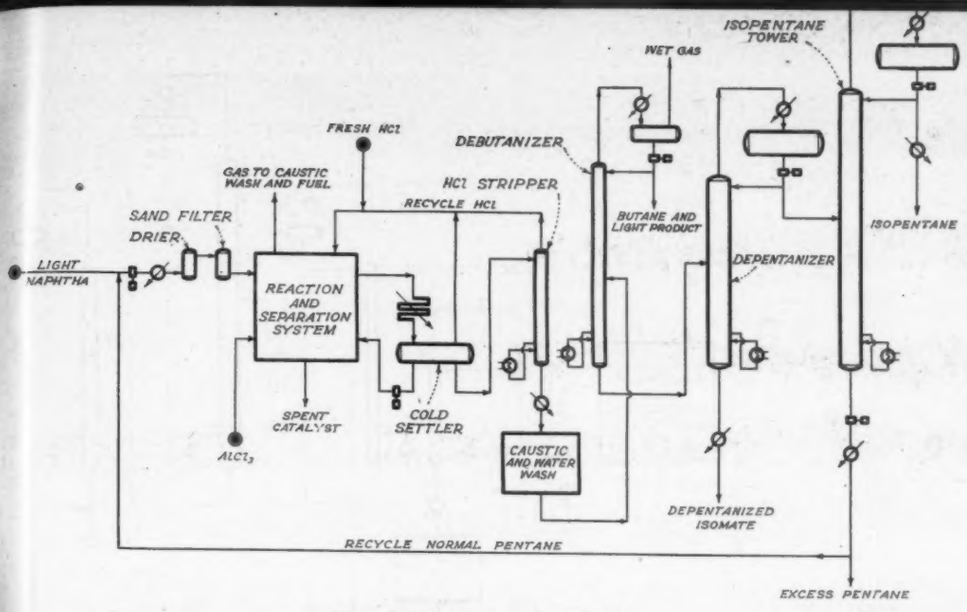


Fig. 1—Whiting Isomate Unit.

continuous butane isomerization process but, with the development of suitable inhibitors, has also furnished a simple pentane isomerization process and made possible the commercial production of neohexane and high octane number aviation blending stocks. The latter process greatly extends the potential source of aviation blending stocks in that light fractions of crude of low octane number which cannot be readily processed to aviation gasoline quality by other methods, are converted in high yield to high octane number aviation gasoline components. The processes also have potentialities for producing aviation gasoline of higher quality than is now being made.

The effect of the structural arrangement of pentanes and hexanes on boiling point, Reid vapor pressure and octane number is shown in Table I. From this table it is clear that the commercial importance of isomerization results from converting the straight or slightly branched hydrocarbons of poor octane number which predominate in crude to more highly branched isomers of high octane number.

TABLE I
Physical Properties of Pentanes and Hexanes

	B.P. °F.	R.V.P. Lb./Sq. In.	Octane Number A.S.T.M. (Clear)	Octane Number AFD 1-C+ 4.0 cc. TEL
Pentanes				
Isopentane	82	21.0	90	100+1.9
n-Pentane	97	15.5	62	87
Hexanes				
Neohexane	122	9.4	94	100+5.6
2,3-Dimethylbutane	136	7.1	94	100+3.6
2-Methylpentane	141	6.5	74	96
3-Methylpentane	146	5.8	74	96
n-Hexane	156	5.0	26	69

In these processes, a paraffinic feed is contacted in a simple reactor with a liquid aluminum chloride — hydrocarbon complex catalyst in the presence of hydrogen chloride to yield a product rich in branched chain aliphatic hydrocarbons. The catalyst is a dark mobile liquid with a specific gravity of about 1.5 and a viscosity slightly higher than S.A.E. 50 lubricating oil. The reactor feed enters the bottom of the reactor as a liquid and undergoes isomerization as it passes upward in contact with the liquid catalyst. In spite of the fact that $AlCl_3$ is appreciably soluble in hydrocarbons this catalyst complex is substantially insoluble in hydrocarbons and may be readily separated therefrom by settling. Furthermore, the particular catalyst complex used has remarkable capacity for retaining $AlCl_3$ added as make-up due to the high $AlCl_3$ distribution coefficient between the complex and hydrocarbon at reactor conditions. This fact has made possible the important improvement of operating in the liquid phase and on a continuous basis without excessive loss of catalyst.

Side reactions that decrease the yield of desirable products and increase catalyst requirements are minimized by the use of suitable inhibitors. The necessity of using such inhibitors depends on the type of charging stock employed and, in some cases, combinations of inhibitors give better results than any single inhibitor.

The character of the isomerization product is also determined to a considerable extent by the operating conditions and is limited by the chemical equilibrium. Table II presents the liquid phase equilibria for butanes, pentanes and hexanes at various temperatures, as determined by laboratory experiments. Although there is substantial agreement in most instances with the theoretical values of Rossini, Prosen and Pitzer (J. Research Natl. Bur. Standards, *27*, 529, 1941), the experimental value for neohexane is somewhat lower and that for isobutane somewhat higher. The only notable discrepancy is the complete absence of neopentane although thermodynamically is the favored isomer at low temperature.

TABLE II
Experimental Liquid Phase Equilibrium Distribution of Butanes, Pentanes, and Hexanes

Temperature	Liquid Volume Per Cent 70°F.	212°F.	300°F.	400°F.
Butanes				
Isobutane	85	75	65	57
n-Butane	15	25	35	43
Pentanes				
Isopentane	95	85	78	71
n-Pentane	5	15	22	29
Hexanes				
Neohexane	57	38	28	21
2,3-Dimethylbutane	11	10	9	9
2-Methylpentane	20	28	34	36
3-Methylpentane	8	13	15	17
n-Hexane	4	11	14	17

On the basis these developments and the use of conventional fractionation systems and recycle, a complete system of isomerization for C4, C5 and C6 paraffin hydrocarbons has been worked out. These isomerization processes may be classified as follows:

1 - Naphtha Isomerization (Pentanes and Hexanes)
  (a) Isomate (Once-through)
  (b) Neohexane (Recycle)
2 - Pentane Isomerization
3 - Butane Isomerization

These processes, their variations and applications are described in more detail in the following paragraphs.

Naphtha Isomerization

The Indiana Naphtha Isomerization Process is particularly suited for the isomerization of hexanes; however, it is usually more desirable to process a light naphtha containing both pentanes and hexanes. The process may be employed on a once-through basis in which event the product constitutes a high quality aviation base stock containing the hydrocarbon components nearly in their equilibrium proportions. Alternately, it may be operated on a recycle basis in which case the higher boiling, low octane number isomers may be selectively removed from the product by fractionation and recycled to the reactor for further conversion. By this latter operation a product consisting predominantly of isopentane and neohexane may be produced. There are various other combinations such as recycle of n-pentane and once-through on hexanes or once-through on pentanes and recycle of hexanes which serve to illustrate the extreme flexibility of the processes. The reactor effluent from naphtha isomerization has been termed "isomate" and will be referred to as such hereafter.

Whiting Isomate Plant

The first of the Indiana isomerization processes to be placed in operation was the Whiting Isomate Plant. This unit, charging 5,000 bbl./day of light naphtha, isomerizes hexanes and pentanes simultaneously, operating once-through on hexanes and recycling on pentane. A simplified flow diagram showing the principal features of the unit is given in Figure 1.

A dry, light virgin naphtha fraction of approximately 160°F. A.S.T.M. end point, anhydrous hydrogen chloride and aluminum chloride are charged to the reactor system and spent catalyst is withdrawn.

The effluent from the reactor system is cooled in an aftercooler and enters a cold settler or

receiver. This settler operates as a vapor release drum as well as a settler for any catalyst carried with the reactor effluent. The product from the cold settler passes to the HCl stripper, where HCl is taken overhead along with a small amount of light hydrocarbon gases. The overhead gases from the HCl stripper and make-up HCl are returned to the reactor system. A remarkably small amount of dry gas is formed in the isomerization process so that HCl losses due to venting are very low. The bottoms from the HCl stripper are caustic and water washed to prevent traces of HCl from entering the fractionation system.

The fractionation system is of the conventional type. The HCl free isomerized product is debutanized and the butanes, consisting of 75% isobutane, are taken overhead. The bottoms flow to the dependanizer tower where pentanes are taken overhead and highly isomerized hexanes are withdrawn as bottoms. The pentane overhead, consisting of 75% isopentane, is further fractionated in the isopentane tower to produce isopentane of 95% purity and a recycle n-pentane stream for further conversion to isopentane. The isopentane and isomerized hexanes form a balanced high octane number light base stock which materially increases the production of 100 octane number aviation gasoline.

As shown in Table III the yield of debutanized isomate is extremely high exceeding 95% by volume. The gaseous products are mainly isobutane which is a valuable by-product. When butanes produced are included with the liquid isomate the yield exceeds 100% by volume.

As pointed out before, the quality of the isomate is determined to a considerable extent by the reaction conditions and is limited by the chemical equilibrium of the reaction. Operating conditions are chosen such that a close approach to equilibrium is obtained. Although, from an equilibrium standpoint lower temperature favors the production of branched chain hydrocarbons, lower temperature also decreases the reaction rate and the degree of approach to equilibrium. Therefore the reaction temperature is selected by balancing reaction rate, equilibrium, catalyst life

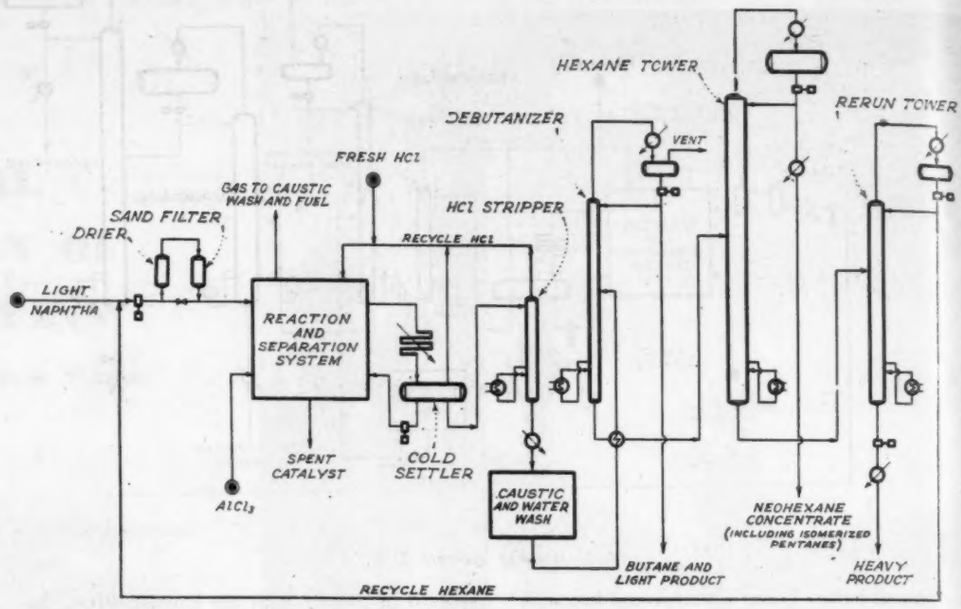


Fig. 2—Utah Neohexane Unit.

and the increased tendency toward hydrocarbon decomposition by cracking at higher temperatures. Table III shows the yields and product quality of the reactor effluent under typical operating conditions on a once-through basis when charging a Mid-Continent hexane feed. The overall effect is primarily one of converting n-hexane (26 A.S.T.M. octane number) to neohexane and diisopropyl. The distribution in the reactor effluent is essentially independent of the composition of C_6 paraffins in the reactor charge. The isoparaffins produced in the process not only have high octane numbers but excellent lead susceptibilities as shown in Table III.

A simplified flow diagram is shown in Figure 2. The reactor system is substantially the same as that described for the Isomate Process. From the debutanizer, the bottoms pass to the hexane tower. Pentanes (75% isopentane) and a neohexane concentrate are taken overhead while hexane recycle is removed as a bottom stream. The hexane recycle is first passed through a rerun tower to separate out about 10% heavy ends before returning to the reactor.

The chemical requirements for the neohexane process are only slightly higher per barrel of product than for the isomate process in spite of the recycle. This is due to the small HCl and catalyst requirements for conversion of the recycle which has been "cleaned" by previous contact with the catalyst.

TABLE III
Yields and Product Quality for Once-Through and Recycle Hexane Isomerization

	Hexane Once-Through	Recycle Ratio 1:1 (Calculated)	Recycle Ratio 2:1 (Calculated)
Yields			
Dry Gas, Vol. %	1.8	3.6	5.3
Butanes, Vol. %	3.8	6.3	8.7
Product, Vol. %	96.8	87.2	85.2
Bottoms, Vol. %	—	7.0	6.2
Product Octane Number			
A.S.T.M. (Clear)	65.0	80.0	88.0	91.4
AFD 1-C+ 4.0 cc. TEL	87.0	100	100+1.5	100+3.6

Utah Neohexane Plant

The Salt Lake City unit of the Utah Oil Refining Company charges 1,750 bbl./day of light naphtha. This unit, an example of the Indiana Neohexane Process, recycles hexanes to produce a neohexane concentrate and operates once-through on pentane.

The quality of the neohexane concentrate is effected by the degree of fractionation and extent to which the hexanes are recycled. In Table III are shown the yield and product quality of neohexane concentrates for 1:1 and 2:1 recycle ratios compared to once-through operation when charging a virgin hexane fraction. Neohexane from virgin naphtha will always contain small amounts of cyclopentane as it is impractical to separate these hydrocarbons due to the closeness of their boiling points. Cyclopentane is in itself a desirable aviation gasoline component. It is also desirable to include any diisopropyl (2,3-dimethylbutane) in the neohexane concentrate since this is another desirable component of

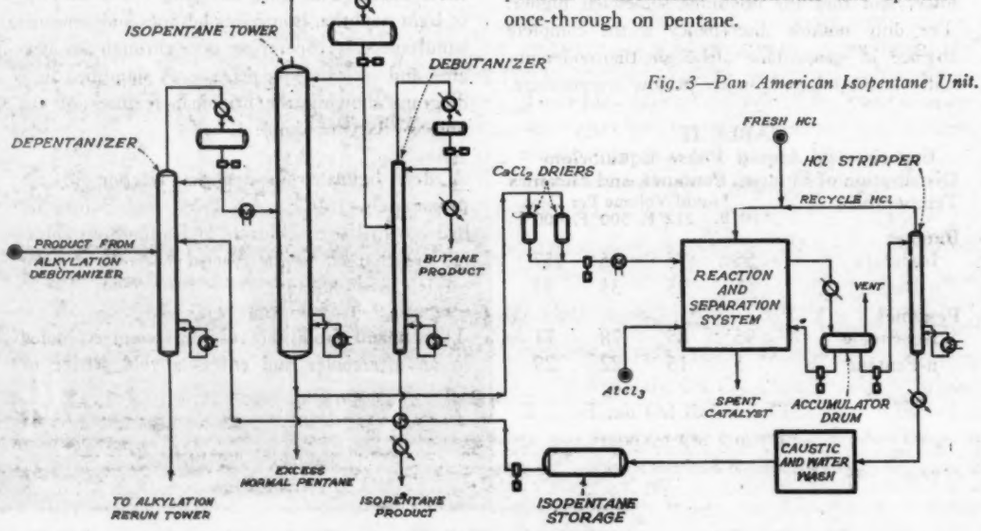
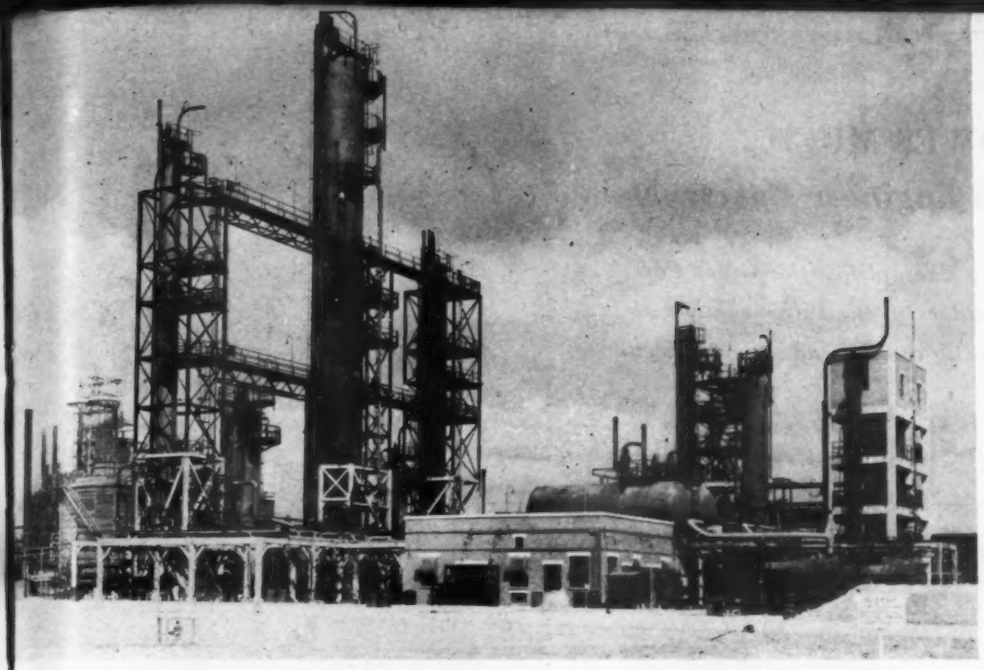


Fig. 3—Pan American Isopentane Unit.



Pan American Pentane Isomerization Unit.

aviation gasoline. For this particular Mid-Continent virgin hexane feed the effect of 1:1 recycle ratio is essentially to convert n-hexane and part of the 3-methylpentane to neohexane. Increasing the recycle ratio to 2:1 results in conversion of 2-methylpentane to neohexane product. Both 2-methylpentane and 3-methylpentane are of marginal quality for aviation gasoline and therefore the desirability of their conversion will depend on the local refinery situation.

The extraordinarily high yields that are obtained with the isomerization process, even on a recycle basis, are shown in Table III. Doubling the recycle ratio decreases the yield of neohexane concentrate only 2% while effecting a considerable improvement on product. The bottoms are also valuable products which may be included in aviation gasoline. The liquid yield (neohexane concentrate plus bottoms) is 94.2 and 91.4% for 1:1 and 2:1 recycle ratio, respectively. The butanes, consisting of 75% isobutane, are valuable by-products and if these are included the yield is slightly above 100% by volume. The only loss is a small amount of dry gas.

Pan American Isopentane Plant

Just completed at the Texas City refinery of the Pan American Refining Corporation is a 1,620 bbl./day unit for isomerizing n-pentane to isopentane.

As shown by the simplified flow diagram in Figure 3, product from the alkylation debutanizer enters the dependanizer. Pentanes are taken overhead and the bottom stream sent to the alkylation unit rerun tower. The pentanes enter the isopentane fractionation tower where isopentane contained in the feed is fractionated out. The n-pentane is taken from the bottom of the isopentane tower, dried, preheated, combined with the HCl and introduced near the bottom of the reactor. A small amount of inhibitor is added. The reactor itself operates on the same general principle as in the case of the naphtha isomerization reactor.

The pentane isomate, passing overhead from the reactor, is cooled and passes to the accumulator drum. This drum acts as a gas separator as well as a catalyst settling drum. The uncondensed gases, principally methane, are eliminated by intermittent or continuous venting. The accumulator liquid is pumped to the HCl stripper and HCl recycle taken overhead. The bottom product from the HCl stripper is cooled, washed with caustic and water to eliminate traces of HCl and is returned to the dependanizer. The isomerized pentanes are returned to the dependanizer instead of directly to the isopentane tower to remove a small amount of heavy ends. As described for the feed, the overhead from the dependanizer passes to the isopentane tower where isopentane is taken overhead and debutanized in the debutanizer giving isopentane of the desired grade.

In Table IV typical yields are shown for a once-through operation. The concentration of isopentane in the reactor effluent is limited by the chemical equilibrium at the temperature of operation as shown in Table II. As in the isomerization processes previously described, optimum operating conditions are determined by balancing reaction temperature, space velocity and HCl concentration. There is practically no degradation to dry gas. The C_6 and heavier product eliminated in the dependanizer are valuable constituents for aviation gasoline. The butanes are 80% isobutane.

TABLE IV
Once-Through Yields on Pentane Isomerization

Reactor Effluent	Wt. %
Dry Gas	0.1
Butane	1.7
Isopentane	62.0
n-Pentane	34.8
C_6 & Heavier	1.4

Whiting and Wood River Isobutane Plants

At the Whiting refinery of the Standard Oil Company (Indiana) a liquid phase, butane isomerization unit having a reactor charge capacity of 4,530 bbl./day is in operation, and another unit is in operation at the Wood River refinery having a reactor charge capacity of 4,250 bbl./day. These units employ the same basic principles that have been described in connection with naphtha and pentane isomerization except for the inhibitors employed.

A simplified flow diagram of the Wood River butane isomerization unit is shown in Figure 4. The flow diagram is self-explanatory in view of the previous descriptions. The units are integrated with alkylation plants and use the debutanizer and deisobutanizer towers of these plants. The limits of conversion are determined by the chemical equilibrium as shown in Table II. A typical example of once-through butane isomerization is given in Table V.

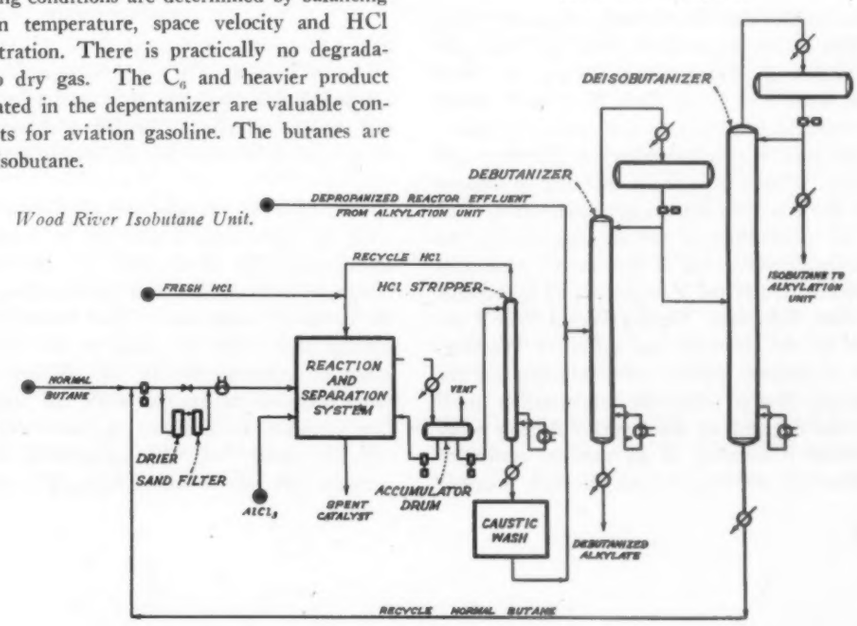
TABLE V
Once-Through Yields on Butane Isomerization

Reactor Effluent	Wt. %
Dry Gas	0.7
Isobutane	50.0
n-Butane	48.6
C_5 & Heavier	0.7

Chemical and Engineering Development

The study of the isomerization of paraffin hydrocarbons has been conducted in the laboratories of this company for more than a decade. Several thousand laboratory experiments were made to accumulate extensive background in the field of isomerization. Pilot plant development based on these fundamental studies resulted in

(*Continued on page 78*)

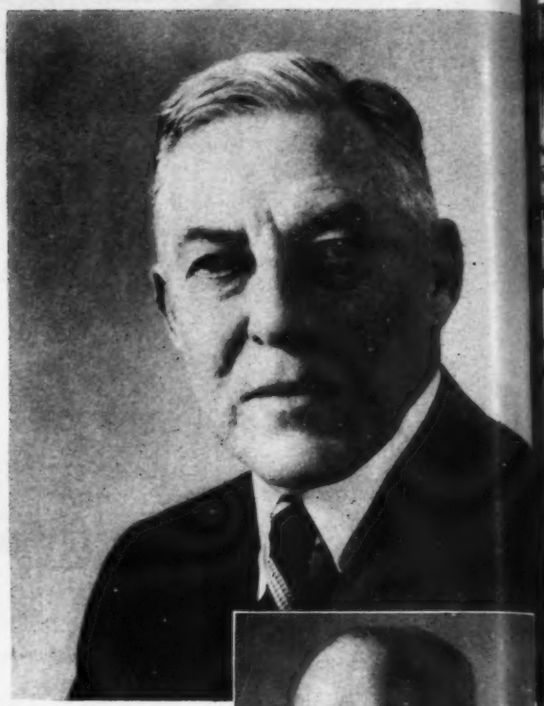


Wood River Isobutane Unit.

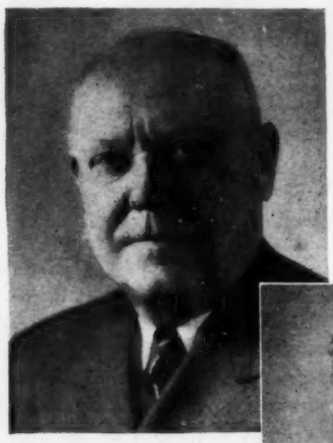
REFINING PROGRESS OWES MUCH
To Work of the Engineer Constructor

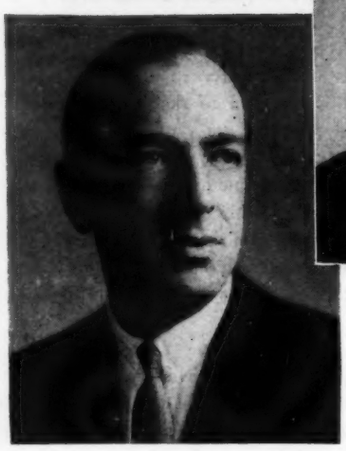
Story of the M. W. Kellogg Company Exemplifies the Great Part Played by Engineering Firms and Builders in the Improvement of Methods and Equipment and in Enabling the Oil Industry to Meet the Demands of War.

M. W. Kellogg—President



H. R. Austin—Vice President





W. L. Smith—Vice President

Above: L. H. Harvison — Vice President

Center Right: F. E. Johnson — Vice President

Right: Paul Ryan — Vice President

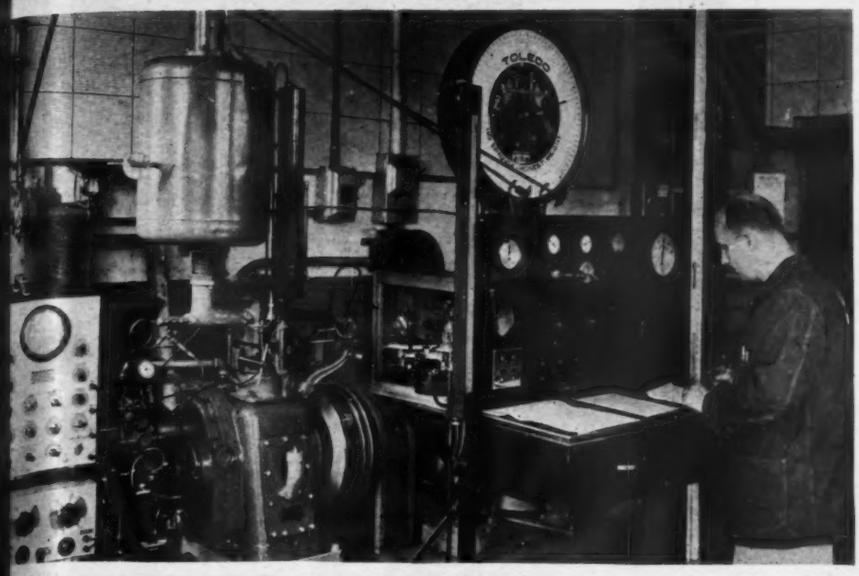
PROPHETIC of the course that was to mark its development as a factor in the progress of refining technique was the first important contact of the M. W. Kellogg Company with the petroleum industry. It came about through an improvement in the method of fabricating shells for Burton stills. The introduction of these stills represented a pioneer step in the cracking of oil to obtain higher yields of gasoline. They were cylindrical vessels of considerable size—as much as 10 ft. in diameter and 30 ft. or more in length—and they were fabricated from steel plate by the then accepted method of rivetting.

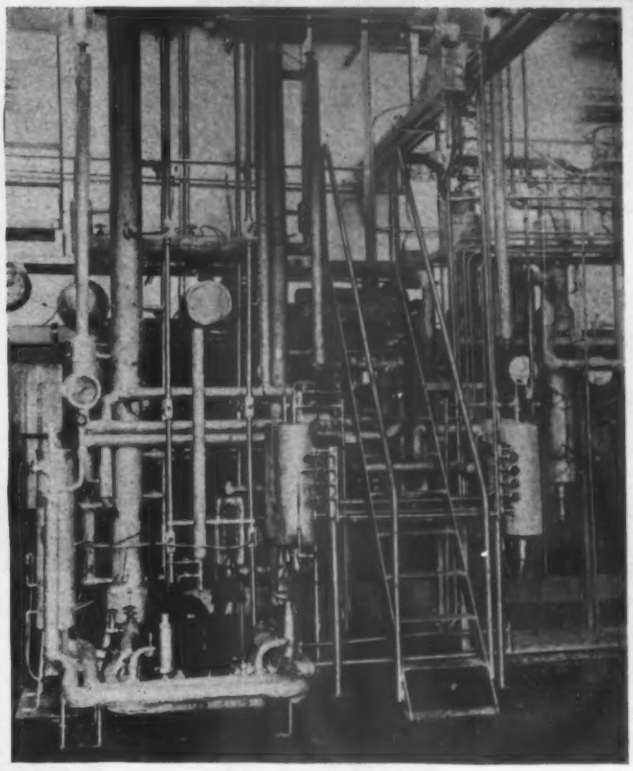
These rivetted joints were a constant source of trouble. When orders for the construction of Burton stills were offered to the head of the Kellogg Company he decided that the difficulty could be overcome by adopting the method of hammer welding which he had studied in the course of a visit to Germany. Accordingly, he ordered an installation of the welding equipment including the machine for providing the gas used to heat the metal. It was found that the German machinery was too light for the heavy plates used in the stills and it was necessary to design and build heavier machines. Even then the first shells built by the process were unsatisfactory. Persistent experimentation, however, solved the problems and brought success with the sixth shell. Thereafter Kellogg filled thousands of orders for this type of equipment.

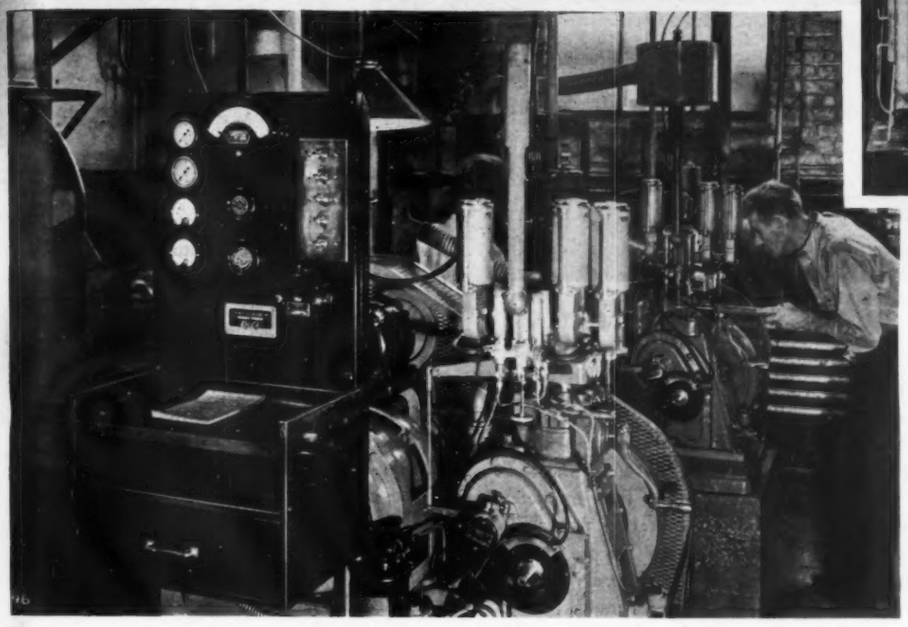
Prior to that time the Kellogg Company, which had its modest beginning in 1905, had been conducting a general foundry business on West Side Avenue in Jersey City, N. J. with special attention to the fabrication of piping for power plants and the construction of chimneys and stacks. It was through its building of Burton still shells in 1915 that its attention was directed to the possibilities of the oil industry but the country's involvement in war shortly afterward temporarily diverted a large part of its energies to other directions. During World War I the head of the company was called to Washington as assistant director of production for the Aircraft Board while the organization itself actively engaged in war work. Among other activities it installed an air pressure system of riveting in the Hog Island shipyard, supplied piping for ships constructed there, furnished a variety of equipment for Air Nitrates Corporation at Muscle Shoal and built over 4,000 hammer welded containers for liquid chlorine for the Chemical Warfare Sectoin of the Army.

At the close of the war the oil industry was ready to enter upon a new era of expansion. Recognizing the broad field of development offered by refining operations and building upon the excellent connections it had formed by installing still shells for most of the country's major oil concerns the M. W. Kellogg Company prepared to expand with the industry. Improvements in cracking methods were developing rapidly and the management of the company felt that it would strengthen its position by having a process of its own to offer rather than by acting merely as a contractor installing equipment on order.

In 1919 Kellogg acquired licensing rights for the Fleming process developed by Richard B. Fleming and during the next four years designed and constructed sixty-one Fleming units in different parts of the country. The first of these was built for the Shell Oil Company at its Martinez, Cal. refinery. The business of the company had increased to the point where larger quarters and a broader organization were needed. In January 1920 a new charter of incorporation was taken out and the site now occupied by the company's plant, at the foot of Danforth Avenue in Jersey City, was acquired.







M. W. Kellogg Laboratories—Above: Engine Testing—Motor Fuels. Top: Engine Testing—Aviation Fuels. Top Right: Propane Fractionating Unit.

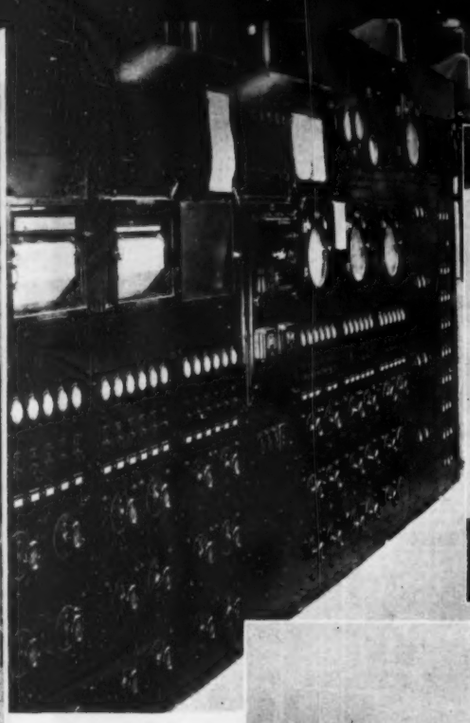
Up to this time practically all cracking had been done in shell type stills at low pressures. Numerous improvements upon their original form had been introduced but they still were subject to various drawbacks. High pressure tube stills were being developed and were showing greater efficiency in the volume of gasoline produced in addition to having advantages in operation.

Foreseeing the ultimate replacement of the old fashioned still equipment by the newer type Kellogg, in 1924, became exclusive sales agents for the Cross process which was owned by the Gasoline Products Company. Later on Standard Oil Company of Indiana and The Texas Company acquired part ownership of Gasoline Products and the company became the licensing agent for the tube and tank process and the Holmes-Manley process which they respectively owned. The great majority of the refineries built under the patents held by the company employed the Cross system, however. In the ten years following 1924 no less than 130 of these Cross units were installed in the United States and other countries.

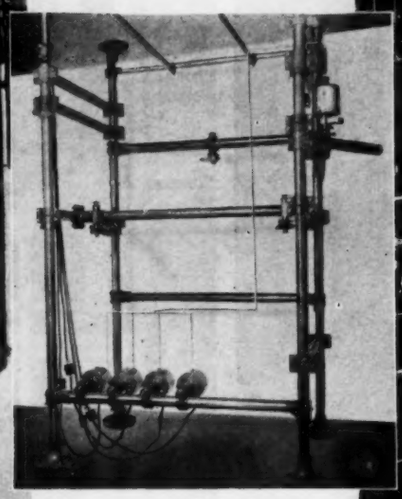
In the meantime the Kellogg organization was adding valuable engineering experience and ideas to its facilities. Realizing that an engineering group having contacts with many refining companies would have an advantage over one limited to the operations of a single concern Kellogg began to accumulate engineering and test run data as soon as it entered the petroleum field. In the early days these data were obtained from actual plant runs on units erected by the company, but this method was not entirely satisfactory due to the cumbersome nature of the runs and the impossibility of varying operating conditions at will to determine optimum operation. Consequently, it was decided that, in order to keep abreast of the technical strides being made in the petroleum industry and to obtain the huge quantity of data necessary to maintain the company's progress, it would be advisable to build a laboratory which would embody pilot plants of sufficient size and flexibility so that a great number of actual test runs could be made for the accumulation of design data, with the assurance that such data could be duplicated in commercial size plants.

The construction and equipping of the petroleum laboratory began in the year 1927 and as new processes were developed the laboratory was constantly enlarged until today it contains pilot plants representing every type of refining process, the sum total of the value of these plants being in excess of a million dollars. With the pilot plants available, Kellogg was able to introduce the tailor-made principle into the design of refining equipment; that is, samples of the individual customer's crudes could be run in the pilot plant and from the resulting data the plant could be designed to suit the operating problem of that particular refiner. This was an important step forward, as previously a refiner was forced to accept a standard design and fit his own crude and production requirements into that design as best he could.

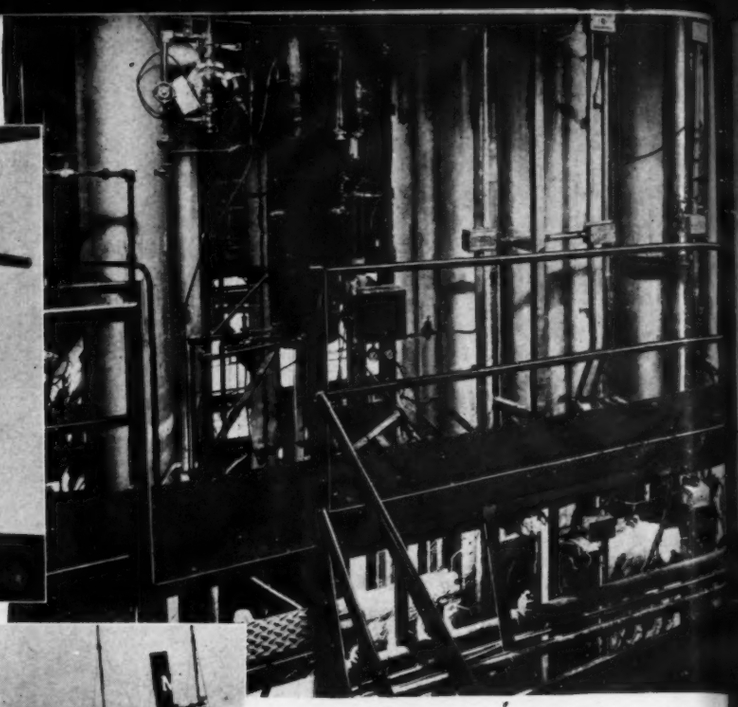
The fundamental purpose behind the Kellogg laboratory is not that it shall engage in abstract research but rather that it shall take basic ideas from whatever source derived and convert them into workable and economical form for commercial application. This program, steadily adhered to, has enabled the company to be a constructive factor in the progress of the refining industry and to attain a relationship to its customers which more nearly resembles that of an architect who embodies his creative ideas in a building intended to serve the special purpose which his client has in mind rather than that



Control Board Hydroforming Unit



Device for Analyzing Pipe Stress.



Pilot Plant Fluid Catalytic Cracking Unit.

250-Ton Tower Built in Kellogg Shops, En Route on 1300-Mile Trip.

of the ordinary builder who simply completes a task laid out for him in exact detail.

A good example of the application of the Kellogg idea was the first of the so-called combination units for refining which was constructed for Standard Oil Company of Indiana at Whiting, Ind. in 1931 with a daily capacity of 30,000 bbl. The equipment installed in this plant was practically the same as had been utilized in other refineries of that period. The departure consisted in so assembling it that instead of a series of installations handling the various steps involved in converting crude oil into finished products the constituents progressed through the plant in a virtually continuous movement. The result was a reduction in the actual cost of the refining process from twenty-five or thirty cents per barrel to ten cents in large plants and to fifteen cents in smaller installations, say of 2,500 bbl. daily capacity.

During the period of expanding activity between the two world wars Kellogg built plants all over the United States and in many other parts of the world including Canada, South America, Europe and the Middle East. During this time about 40 percent of its gross business was in foreign lands. Some of these jobs presented unusual problems. One of the most interesting was the building of the Aruba refinery in the Caribbean for Pan American Petroleum and Transport Company in 1929. It is now under the ownership of Standard Oil Company (N. J.). This was a rush order which called for completion of the plant within ten months. Time did not permit the usual procedure in the design and blue printing of each portion of the plant so it was necessary to order the principal equipment according to arbitrary specifications and to make the design to fit these predetermined requirements. Transportation was a difficult problem so three steamers were chartered at the time when orders were placed and their sailing dates were fixed. By strenuous efforts and a modicum of good luck each ship was able to leave on the appointed date and the refinery was completed on time.

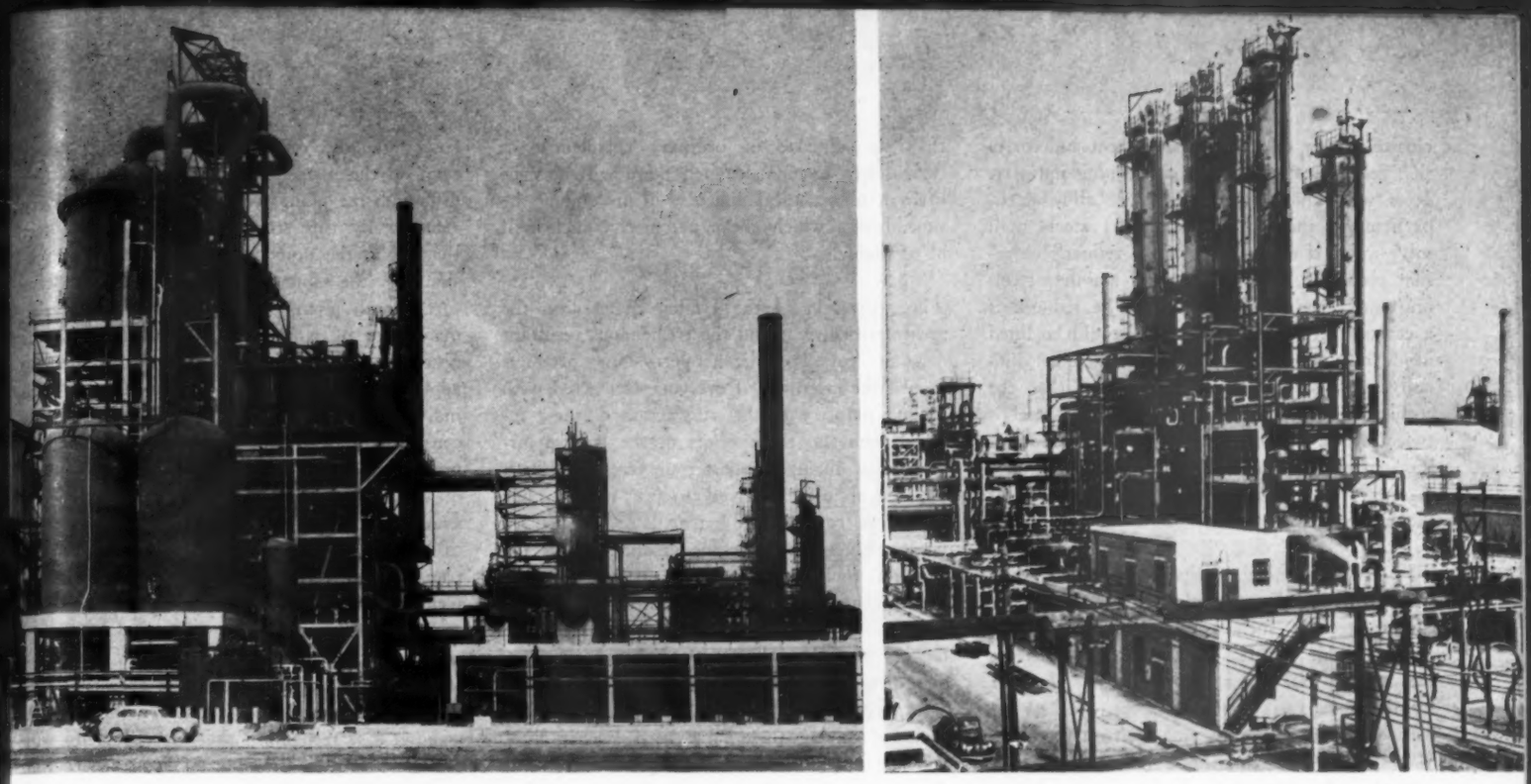
While adopting and improving upon ideas for the advancement of refining methods brought forward by its customers the Kellogg organization was prolific in ideas of its own. One of these was the hydroforming process which functions primarily by converting the normal hydrocarbons contained in heavy naptha into aromatics and so raises the yield of product at an increased octane rating. Adaptation of the process to the production of toluene has increased the pre-war production of toluol many fold. The first hydroformer unit was constructed for Pan American Refining Corporation at Texas City, Texas. The data used in the erection of this unit—the only data available in fact—were obtained from the Kellogg Company's pilot plant in the Jersey City laboratory. The usual intermediate step of a semi-commercial plant was omitted altogether and the result proved that there was no necessity for it.

Other processes in the completion of which the Kellogg group participated were those of alkylation, delayed coking, butane isomerization and others that will not come to full development until sometime after the war.

One of its major accomplishments is the technical development of the fluid catalytic cracking process that is now furnishing a major portion of the enormous output of 100-octane aviation gasoline used to fuel the air war. Probably no other factor has done more to give the United Nations their overwhelming dominance in aerial warfare with the Axis nations than the invention of fluid catalytic cracking. Experimental work with this type of catalyst had been conducted in oil company laboratories but the technical development of the process into the successful art that it now is has come largely from engineering principles and practices worked out in Kellogg's pilot plant, and on which this company holds important patents.

Thousands of test runs in a specially constructed apparatus in which glass tubes replaced metal pipes made it possible to study the changes that went on during the process and to develop the technique for controlling the cracking reaction and for transferring the necessary heat from the regeneration to the reaction step.

The full story of fluid catalytic cracking and how it has given the United Nations a decisive military advantage cannot yet be told. The process, however, has fully demonstrated its efficiency as a method for producing the highest quality of high-octane base stocks for both aviation gasoline and motor fuel. From the viewpoint of the refiner one of its great recommendation lies in its ability to work economically on heavy oils of a wide range of quality, from which a very large percentage of high-value products are obtained at a relatively low operating cost.



War Plants Built By M. W. Kellogg Company—Left: Fluid Catalytic Cracking Unit, Texas City—Rights Hydroformer and Toluene Extraction Plants, Whiting, Indiana.

The advantages of fluid catalytic cracking assure the process a highly important place in the coming peace-time production of gasoline. It is generally agreed that after a short period of readjustment that will follow the close of the war, automobiles will again be produced in new models on a grand scale, and these automobiles will be designed to run on a higher quality of fuel than ever before. These higher standards of automobile fuel will make it necessary for the many refineries that have not installed catalytic equipment during the war to introduce it when peace returns in order to maintain their competitive position after governmental control is removed.

These refineries cannot manufacture the higher-octane post-war gasoline on a competitive basis with their present equipment and methods, and perhaps most of them cannot find the large amounts of capital required for the large plants that have been built to meet war demands.

This threat to the future of the smaller refiner was dispelled last month in an address by L. H. Harvison, vice president of the Kellogg Company, before a gathering of representatives of the technical press, in which he stated that the development of fluid catalytic cracking apparatus has been carried to the point where a small unit can be set up at approximately the same investment cost per barrel of capacity as the largest of the units now operating. This will minimize the financial advantage that large refineries might otherwise hold over small ones.

This leveling of unit investment costs is partly attributable to a unique Kellogg invention which has proved itself to be an indispensible aid in the design of piping systems that are subject to high temperatures, and hence to great stresses due to expansion of metal. These stresses, if known, can be allowed for when coefficients of expansion are known and used for calculation of safety factors. But the calculations to determine such stresses are very complicated since the expansion of a pipe exerts an effect on other pipes and vessels with which it is connected and each of these stresses has to be taken into the calculation. When four points are involved the engineer has to solve 18 simultaneous equations involving 18 unknown quantities; five points raise the number of equations and unknowns to 24. The labor and time required for solving these problems is enormous, and from a practical standpoint impossible. As a result, the usual practice is to design refinery piping systems on the basis of assumed safety factors that are far larger than necessary, thereby using more steel than is actually needed.

This complexity has been reduced to simplicity by the new Kellogg stress-evaluating apparatus. A small model of the piping system or apparatus is built to scale and a series of stresses equivalent to those essential in actual operation are applied at vital points; the apparatus measures electrically the stress at each point of fixation from which the stress at any other point within the system can be readily calculated by the design engineer. The saving of the designer's time, however, is the very least of the advantages of this unique apparatus. The pay-off comes from the substitution of certainty for the uncertainty of assumed factors; the exact size and required strength of the system is definitely known, and the proper factors of safety can be allowed. The practical result has been a great saving in the amount of steel used in the construction of huge metal pipes and vessels that are subject to expansion stresses. It is largely this saving of steel, plus the rational proportioning of all components of the system, that has put Kellogg in a position to build fluid catalytic cracking and other refinery units at a level rate of investment cost, and thus to bring fluid catalytic cracking within the reach of the post-war small refiner.

As befits an engineering concern that has been called on to build war-time oil refining plants amounting to roundly a billion dollars, Kellogg has made sure of its every step into the unknown by reliance on its pilot plants and laboratory at Jersey City. Here is a small fluid catalytic cracking plant so well proportioned and operated that ideas fathered in it have been transferred to full industrial use without the usual intermediate stage of a semi-works plant. It is from here that most of the latest improvements in the construction and operation of fluid catalytic cracking installations have come. Here also are to be seen units for topping, fractionating, thermal reforming and cracking, propane desalting and deasphalting, alkylation and isomerization, hydroforming and isomerization, and other operations in which improvements are shaped up for industrial use, with the aid of supplementary development facilities for catalyst testing, gas analysis, and the engine-testing of motor and aviation fuels that set standards for Kellogg-sponsored projects to meet. Without some of the improvements that have come out of these pilot plants the art of petroleum refining would not be quite what it is today.

From Kellogg's metallurgical laboratory has come a development which appears to be a con-

clusive answer to the problem of heat and corrosion resistant steel for the oil refining industry. It is well known that the newer alloy steels, particularly the Cr-Mo (stainless) steels, will solve most, if not all, of the oil refiner's corrosion problems. But the integral stainless steels are costly; the cost could largely be reduced if a carbon steel pipe, for instance, could be lined inside and out with stainless steel. The difficulty with that arises from the fact that the coefficient of heat expansion of stainless steel is twice that of carbon steel. Any coating of stainless steel over carbon steel applied in an ordinary manner would buckle to a great extent under the action of high heat.

The Kellogg metallurgists have developed a method of bonding stainless steel (18-8) on carbon steel in such a way that the coating cannot buckle at all. This is accomplished at the rolling mill by applying a thin plate of stainless over an ingot of carbon steel when both are at a high heat and their surfaces are in a semi-plastic condition. The union thus formed is firm enough to overcome any differential expansion of the two metals. After the coating has been applied the ingot may be rolled into any desired shape, and even drawn into a very fine wire. Throughout all such manipulations, the carbon steel remains covered with a uniform and undetachable coating of stainless steel. All sorts of useful metal gadgets and utensils have been made of this product, including rustless mess trays for the soldiers at the front.

Another notable recent accomplishment of the Kellogg research laboratory is the perfection of what its staff calls the "synthol" process in which natural gas, consisting mostly of methane, is directly converted into gasoline and other liquid petroleum products. This has been done before by an application of the well-known Fischer-Tropsch process. The point here is that the Kellogg laboratory has developed special catalysts and a technique that has brought the proposition within the range of commercial practicability. This process is expected to assume very considerable importance in the post-war period. It is generally understood that the national reserves of natural gas are somewhat larger (on an equivalent hydrocarbon basis) than the reserves of ordinary petroleum; as these latter become depleted there will now be little or no technical difficulty in prolonging the time during which cheap automotive fuels will be available.

The projection of the United States into the present world war and the tremendous resultant demand for specialized petroleum products turned the attention of everyone connected with the oil industry to the satisfaction of these requirements and the energies of the Kellogg organization during the past four years have been directed almost exclusively to war work. They have been concentrated particularly upon three vital products: high octane gasoline blends for aviation fuel, butadiene for synthetic rubber and toluene and ammonia for explosives.

During this time the company has built more than fifty war plants representing a combined investment of hundreds of millions of dollars. Included among these have been twenty fluid catalytic cracking plants. They have included also twenty-five alkylation and isomerization units for the conversion of gaseous products into alkylate, a constituent of aviation gasoline Hydroforming assumed wartime importance for the production of toluene for explosives and seven hydroformer units have been constructed. To supply butadiene for synthetic rubber, three complete butadiene plants have been built.

One of the noteworthy features in this great construction program was the erection of the large refinery of Cities Service Refining Corporation at Lake Charles, La., completed in May last. This huge plant was built from scratch in a location that involved the clearing of a Louisiana forest. It was the first fully integrated refinery to be built in the United States in twenty years and the largest to be constructed under a single company responsibility.

The tremendous amount of work imposed by the war compelled the company to make some changes in its normal methods of doing business; for example, it was necessary to standardize on the size of the units to be built rather than do the necessary engineering required if a different size plant were to be built for every refiner. By this standardization and the fact that all of the units were being erected at substantially the same time, it was possible to conform to all plants, thereby saving innumerable man-hours of work. In spite of this, it was necessary in each case to make the engineering applicable to the specific requirements of each individual plant. By reason of the fact that construction of many of these war units was proceeding at the same time, the superintendent of construction and his staff, by traveling an average of 5,000 miles per month, were able to keep in touch with all of the projects and transmit any new developments in construction technique to all jobs as soon as they were conceived.

In the readjustment to peacetime operating conditions which the oil industry will soon be making, it is recognized that new problems will come to the fore. In entering upon a period of world wide rehabilitation, rapid expansion and strong competition the refining industry will need not only the benefit of sound engineering and successful experience in construction but each new undertaking must be studied with a view to its ability to operate profitably. Such factors as the quality and extent of its raw material supply, its relationship to transportation facilities and the availability of markets and prospective changes in market demand will call for special study and evaluation. To meet this condition the Kellogg organization is being extended to cover the numerous phases of economic engineering and to provide for its clients expert assistance in weighing all the elements that enter into the determination of commercial feasibility as well as technical excellence.

Through a process of evolution extending over nearly forty years the company has become a fully integrated service institution having at its command a vast accumulation of valuable engineering data and experience of operating conditions in every part of the world. In its steady growth from modest beginnings to a position of broad usefulness in the fields it serves the Kellogg organization is typical of American industrial progress and efficiency.

Tutwiler Refinery of Cities Service, One of Country's Greatest War Petroleum Plants.

5 to 3

U. O. P. thermal cracking royalty is reduced from five cents to three cents per barrel with increased service and broad patent protection

GASOLINE POWERS THE ATTACK — DON'T WASTE A DROP

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UOP

Petroleum Process Pioneers
For All Refiners

The Refiners Institute of Petroleum Technology

Oil Company Staff Changes

Edward G. Seubert

Robert E. Wilson

AFTER fifty-two years of service to Standard Oil Company of Indiana, the past fifteen as chief executive, Edward G. Seubert is relinquishing his more active duties to become chairman of the executive committee of the board of directors from January 1 next.

Robert E. Wilson, now president of Pan American Petroleum and Transport Company, will return to Chicago to become chairman of the board and executive director of the Indiana Company, and A. W. Peake, at present a vice president, will advance to the office of president. His place will be filled by F. O. Prior, now president of Stanolind Oil and Gas Company, an oil producing subsidiary. Mr. Prior will be a director and vice president of the Indiana company and will also be chairman of the board of the Stanolind Oil and Gas Company, Stanolind Pipe Line Company, and Stanolind Oil Purchasing Company as Mr. Peake has been. Mr. Wilson will take over Mr. Seubert's responsibilities as chairman of the board of Pan American Petroleum and Transport Company, Standard's eastern subsidiary.

The reorganization is designed to relieve Mr. Seubert of the greater part of the responsibilities and burdens which he has carried and yet retain for the company the advantages of having his comprehensive knowledge of its affairs and his long experience readily available and his counsel and guidance a continuing factor in executive management. For him personally the change will top off a unique career that began only two years after the company was organized, saw him advance from a mechanic's helper to a seat on the board and officer's status in 1919, put him in the presidency in 1927, and made him chief executive in 1929. He has been president of Standard of Indiana longer than any predecessor.

Mr. Wilson comes to his executive position via the technical route. He was graduated from the College of Wooster in 1914 and did two years of advanced work in chemical engineering at Massachusetts Institute of Technology, where he was later an associate professor after coming out of the first World War a major. Standard of Indiana employed him in 1922 as assistant director of research, put him in charge of a new development and patent department in 1929, and made him a board member in 1931 and a vice president in 1933. He was transferred to Pan American in 1935 as its vice chairman and was elected president in 1937. In 1940 he was selected as petroleum advisor to the Office of Production Management and continued in that position until the Petroleum Administration was established as a separate agency. Since the organization of the Petroleum Industry War Council, he has been chairman of its important economics committee.

A. W. Peake

F. O. Prior

Mr. Peake started in the oil business in 1912, the year he was graduated from Stanford University. In 1916 he went with the Midwest Refining Company, control of which was acquired by the Indiana company in 1921. He has since been with the Indiana company and its subsidiaries and has been a director and vice president since 1930.

Mr. Prior is also a graduate of Stanford. Finishing in 1918 he entered the employment of Midwest. He has been with Standard of Indiana subsidiaries ever since Midwest was acquired and has been president of Stanolind Oil and Gas Company since its formation in 1930.

L. F. GRIFFITH rejoined the staff of Petroleum Machinery Corporation as power engineer in connection with the supply of equipment for power projects in the oil industry and other power developments in the foreign field. Mr. Griffith recently resigned from the War Production Board, as deputy chief, Materials Distribution Section, Power Division of Office of War Utilities.

C. B. MAC GLASHAN has been appointed manager of the Light Oil Department of Shell Oil Company for the Pacific Coast territory. Mr. MacGlashan, a veteran of twenty-two years service with Shell, previously was wholesale salas manager of the company's Oakland division. His headquarters will be in San Francisco.

AMERICAN EASTERN PETROLEUM COMPANY has changed its name to **AMERICAN OVERSEAS PETROLEUM COMPANY.** The company, originally formed in July of this year, manages foreign exploration and development activities of companies jointly owned by Standard of California and The Texas Company with the exception of their Arabian and Bahrein interest.

American Overseas directs exploration and development of properties in Egypt, New Zealand and Australia, and will include the Netherlands East Indies after liberation from Japan. Officers of American Overseas are: E. A. Skinner, president and director; E. M. Butterworth, vice president and director; F. C. Sealey, vice president and director; J. H. MacGaregill, director; C. E. Olmsted, director; H. G. Parker, secretary-treasurer, and H. J. Hawley, manager of exploration. Headquarters are in San Francisco.

Arthur V. Danner

Robert B. Cragin

The Board of Directors of **HOUDRY PROCESS CORPORATION,** Wilmington, Delaware, has announced the appointment of Arthur V. Danner as executive vice-president, and Robert B. Cragin as vice-president in charge of sales engineering and a technical advisor of the corporation. Both have been elected members of the Board of Directors and Mr. Danner has been made a member of the executive committee of the board.

In commenting upon the appointments, Eugene J. Houdry, president of the Houdry Process Corporation said, "The continuance of the corporation's services to users of its processes, making highest grade aviation gasoline and other war products, has necessitated an expanded program of over-all assistance to war industry. The complete laboratory facilities of Houdry Process Corporation have been dedicated to winning the war. Mr. Danner and Mr. Cragin, with their experience in industry and with the Petroleum Administration for War will contribute importantly in carrying out the Corporation's plans."

Arthur V. Danner joins Houdry after seven years with the Socony-Vacuum Oil Company, Inc., where he served as patent attorney. For two and a half years he had been loaned by Socony-Vacuum to the Petroleum Administration for War where he served as chief of the process section in the Refining Division. Prior to joining Socony-Vacuum, Mr. Danner had experience in the chemical industry and as examiner in the United States Patent Office.

Robert B. Cragin comes to Houdry from the M. W. Kellogg Company where he served as director of petroleum research and later as sales engineer. For three years, Mr. Cragin was loaned to the Petroleum Administration for War where he served as assistant director of the Refining Division. At PAW he was closely associated with the aviation gasoline program. Mr. Cragin was the main organizing force of the Aviation Gasoline Advisory Committee, an industry committee created to speed up the production of aviation gasoline in cooperation with the Petroleum Administrator. Mr. Cragin is a graduate of Princeton University with a bachelor's degree in chemistry, and his business experience has been entirely with Kellogg, with the exception of his government service.

JOHN W. de GROOT, vice president of Tuscarora Oil Company Limited, has been appointed president to succeed John P. Fallon who has retired. A. F. Aylsworth succeeds Mr. de Groot as vice president and will retain his former position as superintendent. The Tuscarora Company, a subsidiary of the Standard Oil Company of New Jersey, owns and operates the historic Tuscarora pipeline from Midland, Pa. to Bayway, New Jersey.

Mr. de Groot, vice president and manager of Tuscarora since May, 1943, began his company service in 1919 with the general engineering department of Standard Oil Company (N. J.) at Bayway, following service in World War I as an ensign in the Navy. In 1921, he was transferred to the Bayonne refinery where he served as chief engineer for a number of years. In March, 1940, he was appointed assistant to the president of Tuscarora, and shortly thereafter became vice president.

Mr. Aylsworth, superintendent of Tuscarora since 1940, has been associated with Standard since 1907, having started with the company in Newfoundland. With the exception of service with the Signal Corps in World War I, he has been continuously engaged in pipeline activities, and was formerly head of the inter-refinery pipeline department at Standard's New Jersey works.

DR. EVERETT C. HUGHES has been appointed chief of the research division of the manufacturing department of The Standard Oil Company Ohio), succeeding Dr. R. E. Burk, who is joining the E. I. duPont de Nemours Company. Dr. Hughes was born in Wadena, Minnesota, and received his B. A. from Carleton College in 1927 and his Ph.D. from Cornell University, where he was Heckscher Research Assistant in Chemistry and Physics from 1928 to 1930. He has been associated with Standard of Ohio since 1930. He has been active during the war on a subcommittee to the Technical Advisory Committee of the Petroleum Industry War Council.

J. HOWARD MARSHALL who recently resigned his position as chief counsel and assistant deputy petroleum administrator of PAW has been elected president of Ashland Oil & Refining Company of Ashland, Kentucky. Paul G. Blazer who has been the executive head of the company since its organization in 1924 becomes chairman of the board. It is stated that he will devote his attention particularly to post war plants of the company.

Mr. Marshall, a lawyer by profession, has been particularly active in connection with governmental relations with the oil industry. After graduation from the Yale Law School he served for a time as assistant dean at that institution. In 1933 he went to Washington as an assistant solicitor in the Interior Department and during the days of the National Recovery Administration he served as a member of the Petroleum Administrative Board. In that position he participated in framing regulations and legislation applying to the oil industry including the Connally "hot oil" law. From 1935 to 1937 he was on the legal staff of Standard Oil Company of California leaving there to join the San Francisco law firm of Pillsbury, Madison and Sutro. When the Petroleum Administration for War was established he was recalled to Washington to serve as chief counsel and spent the past three years in that position. In accepting his resignation Administrator Ickes paid a high tribute to his abilities and public service.

(*Continued on page 66*)

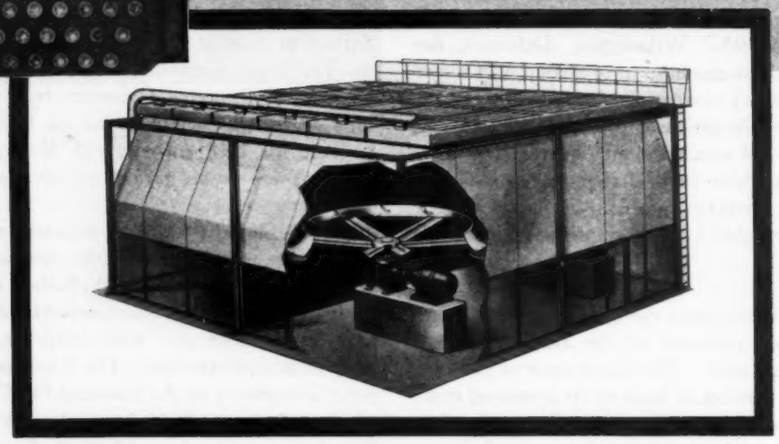
John W. de Groot

J. Howard Marshall

K-FIN AIR-COOLED SECTIONS

are incorporated in the

FIN-FAN HEAT EXCHANGER



Portion of K-Fin tubing. This finned tubing has also proven its effectiveness and durability in shell-and-tube type vapor condensers involving cooling of non-condensibles, gas-to-liquid heat exchangers including steam generating elements, and reboilers.

In the Fin-Fan Heat Exchanger, a joint development of The Fluor Corp., Ltd. and The Griscom-Russell Co., fluid cooling and condensing services are accomplished by G-R K-FIN SECTIONS utilizing Fan-circulated atmospheric air as the coolant. This represents the most recent application of G-R K-FIN ELEMENTS, the patented Helically-Finned Tube developed over fifteen years ago, and used in many thousands of units for heating and cooling air and other gases.

Note the provision in the headers for accessibility to the tube interiors plus the fully demountable supports employed, both distinctive features permitting internal cleaning and replacement of individual elements.

Write for complete information on these standard, interchangeable condensing and cooling sections, and on the Fin-Fan Heat Exchanger.

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ON A SILENT NIGHT . . .

To see the lights coming on again in a war-darkened world holds a special thrill for those whose skill and sweat made what was needed to win the Victory . . . To all of the workers in American industry, we at GATX wish at this holiday season a full measure of the American blessings they have so richly earned.

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Specialists in plate fabrication — manufacturers of pressure vessels of steel, alloys and aluminum — all classes of welding — process equipment of all types — chemical engineering laboratories and service — completely equipped field erection department.

Collapsible Gasoline Containers

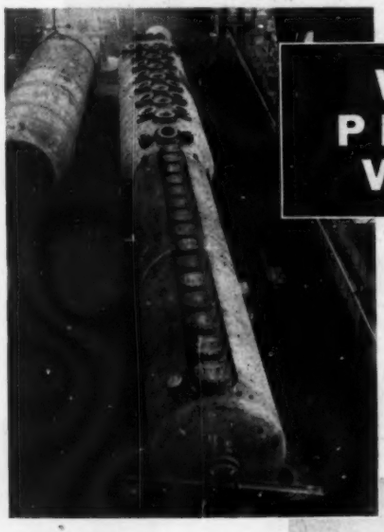
STANDARDIZATION of four sizes of collapsible gasoline containers by the Fuels and Lubricants Division, Office of The Quartermaster General, is expected to speed movement of petroleum products to using units at the front, it has been announced by the War Department.

The collapsible containers, standardized after a gruelling series of tests, will hold 750, 1,000, 2,700 and 3,000 gallons, respectively.

The 750 and 2,700 gallon containers are transportable, and are fitted with rigid plywood frames. They may be set up on the ground, adjacent to using troops, or may be used on flat cars, whenever deemed necessary. Four 2,700-gallon containers, mounted on a flat car, will carry approximately the same gallonage as an ordinary tank car. In Theaters of Operations, tank cars are not always available, it was pointed out.

The collapsible containers are made of cotton duck, impregnated with synthetic resin of the "rubbery" type. The 1,000 and 3,000-gallon "tanks" may be set up anywhere. In addition to the impregnated duck container for the petroleum products, these sizes are equipped with an outer cover of duck, held up by poles, as are the interior containers.

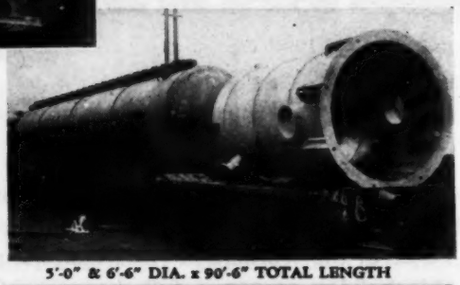
All four sizes of containers are now in use in Theaters of Operation, the Office of The Quartermaster General said.



WELDED PRESSURE VESSELS

HYDROGEN PLANTS
as applied to
CRACKING OF PETROLEUM
HYDROGENATION
OIL SYNTHESIS

5'-0" & 6'-0" DIA. x 72'-0" TOTAL LENGTH



5'-0" & 6'-6" DIA. x 90'-6" TOTAL LENGTH

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8'-0" DIA. x 39'-6" LONG

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and associate company
THE POWER-GAS CORPORATION LTD.
STOCKTON-ON-TEES

Failing Gets "E" Award

GUNS and ammunition are not the only essential supplies of war. One of the primary requirements of troops in the field or in remote stations is a supply of abundant and uncontaminated drinking water. The importance of this provision is emphasized by the recent award to the Geo. E. Failing Supply Co. of the Army-Navy "E" for its production of portable water drilling units thousands of which are in use wherever American forces have penetrated. The equipment used is an adaptation of the regular Failing core drill which has been widely employed in the United States and other countries in exploration for oil.

Tanker Rescues Mexicans

THE Tide Water Associated Oil Company's tanker, Axtell J. Byles, commanded by Captain John D. Baldwin, arrived in New York on October 24 carrying eleven shipwrecked seamen and the second officer of the Mexican tanker Juan Casiano, which was sunk in collision with another vessel during a hurricane in the Gulf of Mexico. A number of other survivors were picked up by other ships. The 7480-ton Juan Casiano was the largest vessel operated by the Mexican Petroleum Administration and was bound from Tampico to New York.

House Organ Honored

TOMORROW'S Tools—Today!, house organ of Lane-Wells Company, was honored recently by selection as a winner in the "Leaders of 1944" contest at the convention of the Direct Mail Advertising Association held in New York, it was announced by M. E. Montrose, vice-president of services and sales of Lane-Wells Company. This publication was cited as one of the best house organs in the United States or Canada. In each of the three years previous, Lane-Wells has received honorable mention in this annual contest.

Furfural Restriction Lifted

FURFURAL, widely used in solvent refining of lubricating oils which has been under Order M-224 since 1942, has now been removed from the critical list of war materials. Due to its many wartime uses, not only in the Furfural refining process, but also in the extraction of butadiene for the synthetic rubber program, WPB has carried it in Group I. This includes critical materials, the supply which is insufficient to fill existing military and essential industrial requirements. It has now been placed in Group II, denoting that the supply is "sufficient for current military and essential industrial needs". Though still under allocation, the prospect is that the supply will be sufficient to fill essential commercial requirements.

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Combining in one organization the largest and most complete geophysical research facilities in the world together with unexcelled equipment, experienced field crews and proven interpretation technique, Western Geophysical Company meets every requirement of operators desiring a *complete* and well-rounded geophysical service.

Western's seismic and gravity crews are now operating in all parts of the United States and in South America. Western service is available for surveys in any part of the world. Inquiries are invited.

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UOP Royalty Reduction

UNIVERSAL OIL PRODUCTS COMPANY has announced, effective November 1, 1944, the third reduction of royalty rates in its history. The royalty rate for U.O.P. thermal cracking will be three cents instead of the previous five cents per barrel.

In 1922, when the first U.O.P. cracking unit was installed the royalty rate was fixed at 15 cents per barrel throughput and a yield of 21 percent of gasoline was guaranteed.

By 1934, despite the enormous increases in yield and quality of products the royalty was lowered one-third or to 10 cents per barrel. Again in 1938—just four years later, the process was still further improved and again the royalty was cut; this time in half, or to five cents per barrel.

From 1922 to 1944 the yield of gasoline has been increased from 21 percent to over 70 percent on a comparable charging stock, services to licensees have expanded, while the royalty rate has been reduced from 15 cents to 3 cents a barrel—an 80 percent reduction.

This represents three times the original yield of gasoline, while the reduction in royalty has been to one-fifth of its initial rate.

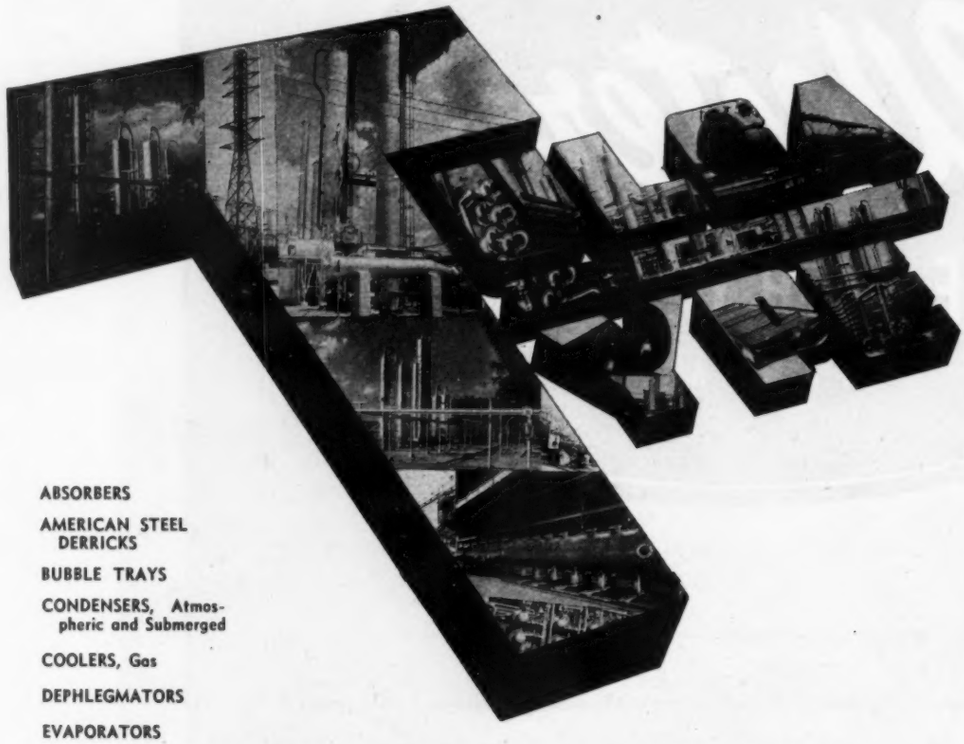
Universal will give more service and will continue to give broad patent protection.

PIWC Committee Changes

WILLIAM R. BOYD, JR., chairman of the Petroleum Industry War Council, has announced a number of committee changes in that organization. Alfred Jacobsen, president of Amerada Petroleum Corporation, becomes chairman of the committee on National Oil Policy, succeeding the late John Brown. B. Brewster Jennings, president of Socony Vacuum Oil Company becomes a member of the committee. Dr. Joseph E. Pogue, vice president of Chase National Bank, is added to the committee's membership. W. Alton Jones, president of Cities Service Company, and B. Brewster Jennings are named as members of the Economics Committee. Mr. Jennings also is appointed to the place formerly held by Mr. Brown on the Committee on Renegotiation.

1943 EDITORIAL INDEX NOW AVAILABLE

A COMPLETE index of all articles and editorial material appearing in the 1943 issues of WORLD PETROLEUM, together with a cross index of authors is now available. Copies of this index will be mailed upon request without charge. Write direct to WORLD PETROLEUM, 2 West 45th Street, New York 19, N. Y. for your copy.



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AMERICAN STEEL DERRICKS
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HEAT EXCHANGERS
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PLANTS, Natural Gasoline
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REBOILERS
STEEL, Structural
SUPERHEATERS, Steam
TANKS, Pressure
TOWERS, Bubble
VESSELS, Pressure

Natural Gasoline and Refining Equipment

IN WORLD-WIDE USE

We are pleased to announce the appointment of Mr. Edward L. Carter and associate Mr. Dermont T. O'Connor as export representatives with offices at Room 1940, 30 Rockefeller Plaza, New York City, New York. Mr. Carter is a graduate Petroleum Engineer with over seventeen years of both domestic and foreign experience in engineering and operating phases of the Petroleum Industry. Mr. O'Connor is a veteran production superintendent with long experience in most all domestic and foreign oil producing fields.

All inquiries and correspondence related to the export market will be handled through the New York Office.

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Revolutionizing an industry

ONE of the leading Research Engineers had stated in the course of a paper that there had been no basic changes in steel for twenty-five years and that he sees no immediate prospect of any such changes.

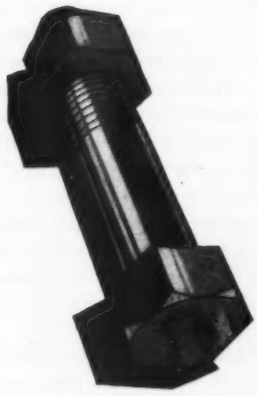
He goes on, however, to say that by adapting certain well-known processes, immense improvements can be made. This is illustrated by the fundamental changes which were made when " Newall Hitensile " bolts were developed many years ago.

The introduction of " Newalloy " which followed after a long interval of experiment and research, carried the strength of bolts to the highest point which they have yet reached.

It is to be noted, however, that " Newallastic " bolts and studs, which came later, are much more resistant to fatigue than are normal types.

" Newall Hi-tem " are, more or less, the same as " Newallastic " with the essential difference that they are made in steel possessing non-creep qualities.

This is a short résumé of the development of Newall bolts which are all branded with their distinctive marks.



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★ ★ ECHOES FROM THE WASHINGTON OIL FRONT ★ ★

By W. J. Maddox, Chief of World Petroleum's Washington Bureau

War stocks Liquidation

Major Schoenbaum

V-E DAY will find the Army with a meticulously worked out plan for handling all adjustments necessary in procurement and distribution of petroleum products step by step from then on till the war effort is liquidated. In charge of devising the means for carrying out the program is Major George H. Schoenbaum, head of the newly organized Demobilization Branch of Army's Fuels and Lubricants Division, and a former Jersey Standard man.

It is Major Schoenbaum's job to work out the details of the basic plan handed down by Lieut. General Brehon Somervell, Commanding General of the Army Service Forces, so that when the time comes specific directives from the chief can be carried out promptly. One of the big concerns will be the "turn around" necessary in routing supplies on V-E Day, when the European theatre is liquidated and the all-out effort is switched to the Pacific.

One phase of the job is planning to keep the proper personnel in the Fuels and Lubricants Division to insure that the required functions are carried out. In some instances the men are actually being schooled by a sort of dress rehearsal in just what each will do when the time comes. Two periods of activities are envisioned: Period 1, from V-E Day to V Day and Period 2, after V Day. Each period will have its own problems, and the adjustments are expected to come fast with almost daily changes.

Practically every officer who will be concerned with the work has had previous oil company experience. Some ninety of the hundred or so officers in the Fuels and Lubricants are industry men. The industry can rest assured that plans for demobilization will be carried out by trained men who understand petroleum problems and will be accomplished with as little disturbance to the industry as possible and yet to the best advantage of the army.

Ploesti Mystery

STATE Department officials are quietly but intently watching for some word from Moscow on the condition of the Ploesti oil fields of Romania. Thus far the Russians have revealed nothing and appear disinclined to grant American and British petroleum interests permission to examine their properties in the Russian occupied areas. Even top-ranking U. S. Army officials are as much in the dark as industry as to the condition of the fields and their potential ability to help oil the rest of the war against Germany. It is thought likely that the subject will come up at the forthcoming conference between Churchill, Stalin and Roosevelt.

Oil and Air Transport

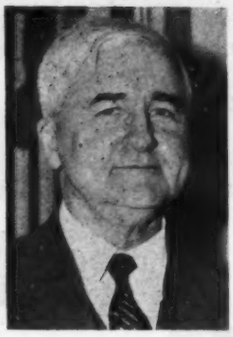
Orville Harden

IN testimony offered the Civil Aeronautics Board recently, Jersey Standard Vice President Orville Harden pictured postwar expansion of American air transport into international fields as a vital aid to the American oil industry in its foreign operations—exploration, refining and distribution. Much of the world outside of the United States, he emphasized, has been only lightly prospected for oil, and the Jersey executive predicted that if Americans continue to participate in exploration they will need air transportation that will cut great distances into hours instead of weeks and months.

As to the magnitude of American interest in foreign oil operations, Harden recalled for the Board the fact that direct investment of United States capital amounted to $1,250,000,000 just prior to the outbreak of the war, about one-fifth of the total direct investment abroad by this country. Overall American participation in foreign petroleum trade in all branches then was about forty percent—more than that of any other nationality. During 1938, the first full peacetime year, forty-four percent of all foreign oil consumption outside Russia was supplied by Americans, who owned some 25 percent of the refining capacity in foreign countries and about 40 percent of the world tanker tonnage.

"There is a very important aspect of American participation in foreign oil that does not directly appear in the U. S. Statistics on foreign trade," Harden pointed out. "It is the very substantial flow of petroleum among foreign nations, in which Americans participate by virtue of their ownership of foreign reserves. For example, prior to the war such American operated foreign sources supplies some thirty percent of foreign oil consumption. Thus there is a large American oil industry operating entirely outside of the United States and requiring adequate facilities for communication and transport by air between foreign nations entirely aside from service to and from this country. And the successful operation of this business contributes to American prosperity."

Operating Costs of "Inches"



Jesse Jones

AT last Secretary of Commerce Jesse Jones has revealed some operating costs and other figures concerning the "Big Inch" and the "Little Big Inch" pipe lines. Having rebuffed heretofore all efforts to smoke out these figures, Jones may now be throwing out a bit of preliminary sales talk looking toward the post-war disposal of the lines. Maybe there is some significance in his remark: "It should be possible to sell the lines to private industry with reasonable allowance for depreciation." Which would seem to be an invitation to step up and do a little dickering.

While the two big pipes are represented as paying "handsomely," Defense Supplies Corporation is currently in the red some 200 or 250 million dollars through its payment of excess transportation costs to the East Coast in place of the normal tanker shipment. Jones believes that it should be possible after the war to operate the lines in competition with ocean tankers and other transportation facilities in moving petroleum from the Southwest to the East.

Operating cost of the "Big Inch" is 38 cents a barrel of crude, according to Jones. This includes gathering cost in the field, and depreciation and amortization of the investment in 20 years, including interest on working capital. Operating costs of the products line are estimated at 24.3 cents a barrel. In selling crude and products at the eastern end, DSC adds 80 cents a barrel to the posted price of crude and 65 cents to the refinery price of the products. Oil companies, however, get a refund of between 21 and 22 cents on crude and between 22 and 25 cents on products a barrel.

The average net profit on a barrel of crude thus amounts to about 20.5 cents and the average on products is 17.2 cents. Figured on a basis of 320,000 b/d from the "Big Inch" and 200,000 b/d from the "Little Big Inch," DSC nets at least $99,100 daily on the two operations. Jones estimated the value of oil in the two lines at any one time at approximately $21,904,000.

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OIL COMPANY STAFF CHANGES

(*Continued from page 57*)

FRANCIS S. McILHENNY, JR. has been appointed assistant secretary and assistant treasurer of Sun Oil Company. His father was a vice president and director of the company until his death in 1927. Mr. McIlhenny, Jr. was born in Philadelphia and studied law at the University of Pennsylvania. He entered the employ of the Sun Company in 1939, in the treasury department where he continued until he entered the United States Naval Reserve in July, 1942. He was promoted to Lieutenant, and was serving as personal aide to Rear Admiral M. F. Draemel, Commandant, Philadelphia Navy Yard, when his release was requested by the Sun Oil Company, owing to the exigencies by its vast war program.

E. G. McKEEVER who has served as executive vice president of Pan American Petroleum and Transport since 1937 will succeed Dr. R. E. Wilson as president effective January 1. He began his career with Pan American in 1915

E. G. McKeever

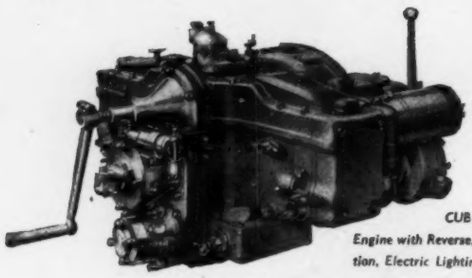
and has held many positions of responsibility in various activities of the company. Mr. McKeever also becomes president of the American Oil Company, Mexican Petroleum Corporation and Lord Baltimore Filling Stations, Inc.

Donald J. Smith will become president of the Pan American Refining Corporation—operating refineries at Texas City and Baltimore—Pan American Production Company, Pan American Pipe Line Company and Pan American Gas Company with producing and pipe line properties in Texas and Louisiana, and Mexican Petroleum Corporation of Georgia which operates a refinery at Savannah. His headquarters will remain in New York City. Mr. Smith joined Pan American in 1927.

P. J. Sweeny, manager of the refinery at Texas City, will be made a vice president of the refining company. Charles H. Wagner, general manager of the American Oil Company, with headquarters in Baltimore, will be added to the board of directors of that company.

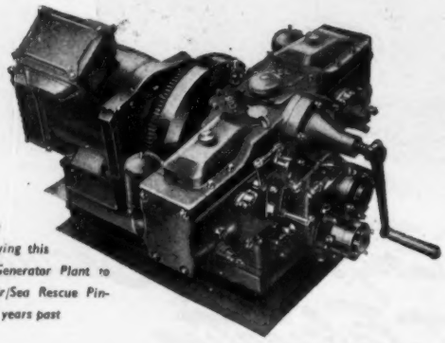
(*Continued on page 70*)

MARINE · STATIONARY · VEHICLE



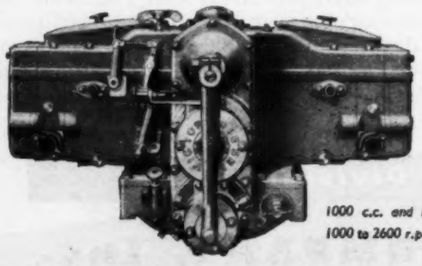
CUB 12 h.p. Marine Engine with Reverse, 2 to 1 Reduction, Electric Lighting and Starting

The World's Finest



We have had the honour of supplying this standard CUB Generator Plant to R.A.F. 60 ft. Air/Sea Rescue Pinnaces for several years past

Small Diesel



1000 c.c. and 1135 c.c. 2 cyls., 1000 to 2600 r.p.m., 300 lb. weight

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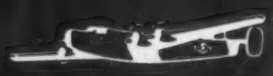
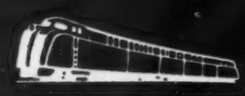
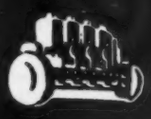



5 *big advantages of* PORUS-KROME*



1 PORUS-KROME applied to the cylinder walls of gasoline and Diesel engines multiplies the life of the cylinders from 4 to 20 times.

2 PORUS-KROME on the cylinder walls multiplies the life of the ordinary piston rings from 3 to 5 times.

3 PORUS-KROME, with its thousands of tiny pores and channels which hold lubricating oil and feed it back as needed, improves lubrication and holds lubricating oil consumption at a constant low level.

4 PORUS-KROME and piston rings wear so slowly that high power development is maintained for many more hours . . . many more miles . . . than with ordinary cylinders.

5 PORUS-KROME means greater engine reliability because it reduces scoring and scuffing and the risk of piston seizure and because it cuts down the number of overhauls caused by cylinder and ring wear.

All of these advantages add up to a substantial saving in engine operating costs.

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Good for the Life of your Engines

*PORUS-KROME is pure, hard chromium which is applied to cylinder bores by the patented Van der Horst process. It has tiny pores and channels in its surface which serve as reservoirs for lubricating oil, feeding it back as needed. It reduces corrosion and wear and multiplies cylinder life 4 to 20 times.

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AN AFFILIATE OF DRESSER INDUSTRIES

(*Continued from page 66*)

D. W. HARRIS, Shreveport, La. was elected president of the Arkansas Natural Gas Corporation at the annual meeting of directors in New York.

Mr. Harris served as vice president and general manager of the company and its subsidiaries, Arkansas Fuel Oil Co., Arkansas Louisiana Gas Co., and Arkansas Pipeline Co., since 1928.

Under Mr. Harris's management the company has had a steady growth and is one of the leading oil and natural gas properties in the South. It pioneered in the discovery and development of the vast East Texas oil field and the Rodessa, Sligo and Lincoln Parish, Louisiana fields.

The new president of the Arkansas Natural Corporation has held several official positions with Cities Service Company, and its subsidiaries in Denver, Bartlesville, Okla., and in New York. He is a director of the American Gas Association, a member of the Bankers Club of New York and has been active in all affairs of the oil and gas industry.

PHILLIPS C. SALMAN, has been appointed assistant comptroller of the Socony-Vacuum Oil Company, Inc., to succeed F. R. Ficken, who retires on Dec. 1. Mr. Salman has been with the company since 1919 and has been general auditor for the last three years. He is a charter member and a director of the Institute of Internal Auditors.

HARRY E. HALL has been appointed manager of the Shell Company's railroad sales department. Mr. Hall, who has been administrative assistant to P. E. Lakin, vice-president in charge of marketing, replaces J. S. Sawyer, who has been transferred as manager to the asphalt sales department. Mr. Hall, a graduate engineer, received his degree at Stevens Institute. He joined the Shell Company in 1926 as a lubrication engineer with headquarters in Chicago. Since that time he has held assignments in various branches of the marketing department both in the field and in Shell's New York offices. In his new position he will supervise general sales and marketing policies of his department.

Harry E. Hall

Craftsmanship in a *Gasket for EVERY Job!*

Typical of our ability to furnish gaskets in any size, is the recent order of eight-141 3/8" OD x 140 3/8" ID Armco iron Stevens Precision-Built Gaskets for installation in octane towers of one of the leading Mid-Western oil refineries.

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Stevens Precision-Built Gaskets go into vital installations wherever oil is produced. They are the vital seal for maximum performance. This is the only plant manufacturing metal-asbestos filled gaskets West of the Mississippi — closest to the source of supply for every Western need.

Gaskets of Copper, Aluminium or other metals.
All types of Rubber Gaskets.
We can build any size or type gasket— you furnish the drawing or template.

STEVENS Ring Type Cylinder Head Gaskets. Guaranteed not to blow-out or burn-out under high pressure. The best cylinder head gasket made for any gas engine your money can buy—not a critical material.

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Oil Property Map of Colombia

Scale: 1 to 1,000,000
Showing in Color

1. Concessions in force of major operators
2. Private oil properties, with firm title
3. Concessions tested and surrendered
4. Location of all wildcats drilled in the country; depths, oilfields; pipelines and stations
5. Concession applications officially accepted

Measures 1.80 x 1.05 meters (6' x 3.5')

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Texaco's Disability Plan

A hospital and surgical benefits plan for employes of The Texas Company and domestic subsidiaries is now in effect throughout the United States, it is stated by Harry T. Klein, president of the company. Nearly 19,000 eligible Texaco employes, or approximately 93 percent, throughout the country already have become members of the plan, which went into effect November 1.

The plan, a voluntary one, provides benefits for hospital confinement and surgical operations not otherwise covered by workmen's compensation or similar provisions. Benefits include payment at the rate of four dollars per day for each day the employe is confined in a hospital, up to 31 days for each period of disability; a surgeon's fee allowance which provides up to $150 for some major operations and smaller amounts for lesser operations; and reimbursement up to $20 for incidental hospital expenses such as operating room, x-rays and tests. The plan costs the individual employe 50 cents a month. The company pays the balance.

Benefits under the Texaco plan do not interfere with but are in addition to any other hospital and surgical benefits to which the employe may be entitled under any other insurance policy or because of membership in any association.

MILITARY PIPE LINES

(*Continued from page* 41)

needed that no cargo space could be spared to bring up the pipe needed to extend the line.

Engineers figure that the military pipe line pays for itself every twelve days in the tonnage of material it is able to transport; that 4,500 tons of gasoline a day is equal to 100 percent return by weight every twelve days, or even less. This fact was little realized at first, and for this reason the Engineers at times lacked materials for continuing pipe line construction.

To a recent date, it is estimated that probably $100,000,000 has been spent on pipe line and equipment by the Army. The military pipe line enables the Army to deliver bulk gasoline to forward areas without cluttering the roads with tank trucks. One of the fears entertained by the military in planning the invasion was that the transportation of supplies by truck would be bogged down by traffic congestion. However, the pipe line for petroleum has solved this problem. It is estimated that each pipe line put in removed 400 trucks a day from the roads, thus clearing the way for other cargo needed up front.

Engineers figure that the pipe line is economical of tonnage, even when it is being built, since it requires only 30 tons per mile for the 6-inch and 16 tons per mile for the 4-inch pipe.

HOWARD PAPE has been appointed vice president of W-K-M Company, Inc., Houston, Texas, manufacturers of the Through-Conduit Lubricated Gate Valve.

Mr. Pape has a long history of association with the oil industry, having joined the Tide Water Associated Company in 1915 and a year later becoming associated with Cosden & Company (now Mid-Continent Petroleum Corporation) at Tulsa.

After ten years of service as chief engineer and mechanical superintendent, he entered the service of Crane Company for the promotion of sales to the oil industry. In 1935 he was transferred to the headquarters in Chicago as manager of their Valve and Fitting Departments.

His long history of association with the oil industry's valve problems make him a substantial asset to the W-K-M organization.

Announcing—
QUIMPACT
QUIMBY PUMPS
the new Quimby close-coupled centrifugal
Pump
● Compact, rugged, efficient, low cost.
● Hydraulically and mechanically balanced.
● Double volute construction on larger sizes to eliminate shaft deflection.
● Adjustable foot under pump frame supports pipe loads.
● Sealed shaft sleeve protects entire shaft extension.
● Sizes 1 in. to 6 in. for capacities to 1000 GPM, heads to 450 ft., temperatures to 300°F.
QUIMBY PUMP COMPANY
INCORPORATED
Division of H. K. Porter Company, Inc.
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Newark, N. J. · New Brunswick, N. J. · Mt. Vernon, Ill.

OXLEY CAN TACKLE IT!

CONSTRUCTION, ERECTION OR REPAIR OF STORAGE TANKS BY ELECTRIC WELDING

Oxley bring highly specialised experience to the design, construction and erection of large-capacity arc welded oil storage tanks in all parts of the world.

Unique methods of construction on site enable Oxley to erect tanks, above or below ground, with speed and efficiency.

They can also execute repairs, by arc welding, of all kinds of corroded, damaged or worn-out plant.

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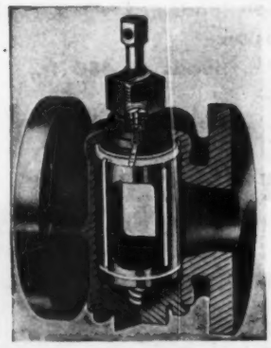
Newman-Milliken lubricated plug valves are used on the severest refinery services. They never leak or jam and will solve your corrosion and abrasion problems. A Newman-Milliken Valve is one of the simplest made having only eight parts including a cylindrical plug, consequently all parts are interchangeable and there is no gland packing or gaskets to renew from time to time causing a breakdown of the line. You can fit these valves and be sure of trouble-free service well beyond the life of the ordinary type of valve.



★ This sectioned illustration of a flanged Newman - Milliken Valve shows the cylindrical plug and lubricant ducts which seal the valve against leakage and ensure easy operation at all times. A rectangular port valve is shown, but full round port valves are also manufactured.

NEWMAN-MILLIKEN

Glandless Lubricated Plug Valves

IN SUITABLE TYPES TO MEET EVERY OIL SERVICE REQUIREMENT

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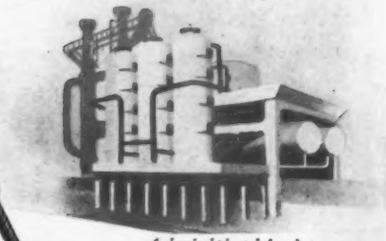
TO WEATHER POST WAR *UNCERTAINTY*



A chemical plant designed, fabricated and erected by Blaw-Knox for large midwest manufacturer.

Naturally you want to establish yourself quickly and permanently in the post war era. To help you, Blaw-Knox offers engineering and products of wide range. It also has the facilities and personnel to manufacture for you, all or parts of your products.

One of the most important activities at Blaw-Knox is the Process Equipment Department, which among other things, specializes in the design and manufacture of equipment for the carrying out of chemical reactions by both the batch and continuous processes. This department is fully qualified to render a complete service from building pilot plants to equipment for full scale production.

Blaw-Knox leadership in the origination and fabrication of products for so many fields of industry is a ground for confidence that it can be of help to you if your business comes within the scope of its activities. Many Blaw-Knox products now of international reputation were originated to fill the needs of one manufacturer. Perhaps the Blaw-Knox umbrella of industrial coverage can include worth while services to you. May we talk it over?

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A PACEMAKER FOR AMERICAN INITIATIVE AND INGENUITY

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SPECIAL ORDNANCE DIVISION, Bofors Anti-Aircraft Gun Mounts and Mechanisms

PITTSBURGH ROLLS DIVISION, Rolls for Steel and Non-Ferrous Rolling Mills

POWER PIPING DIVISION, Prefabricated Piping Systems

BLAW-KNOX DIVISION, Chemical & Process Plants & Equipment, Construction Equipment, Steel Plant Equipment, Radio & Transmission Towers . . . General Industrial Products

COLUMBUS DIVISION, Ordnance Matériel

UNION STEEL CASTINGS DIVISION, Steel and Alloy Castings

MARTINS FERRY DIVISION, Bofors Anti-Aircraft Gun Mounts

BLAW-KNOX SPRINKLER DIVISION, Automatic Sprinklers and Deluge Systems

Five Blaw-Knox Plants have been awarded the Army-Navy "E" for war-production excellence

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TUBE CLEANERS AND EXPANDERS

The manufacture of tube cleaners and tube expanders that give maximum service under the most extreme conditions is Airetool's aim. And this aim is a reality because of Airetool's unique developments. In Cleaners they are Airetool's more powerful motor that can be loaded down to 50 rpm without stalling, the Airetool new form cutter that eliminates tracking and saves tubes, the precision slip-fit construction of special alloy steel and other features. In Expanders they are the special tested designs, the precision construction, their long life and others. No wonder users everywhere say Airetool Cleaners and Expanders are "Tops".

Airetool Cleaners are made for tubes to ½" to 24" I.D.; straight or curved. Airetool Expanders are made for tubes ½" to 12" I.D.

Write Dept. WP for informative, instructive literature.

AIRETOOL MANUFACTURING COMPANY

Airetool & Yost-Superior Factory Bldg.

SPRINGFIELD, OHIO

Commercial Isomerization

(*Continued from page* 49)

operable, continuous and from a mechanical viewpoint, rather simple processes. As soon as the necessity for rapid expansion in aviation gasoline production was realized, the results of the exploratory and pilot plant experiments were carefully appraised from processing and mechanical engineering aspects and designs of large scale plants undertaken.

Projected operations on a large scale necessitated reconsideration of problems concerning the handling of the various materials used in the processes at a time when special equipment was difficult to obtain. Means for continuously injecting granular materials into vessels operating under pressure were improvised using types of equipment already available. Many other problems were successfully solved in the construction of the five plants just described.

These commercial installations represent the combined efforts of the Research, Operating and Engineering Departments and the authors acknowledge the contributions by many members of the company to the success of this development.

Conversion Plant For Hugoton

PLANS are underway for the installation of a natural gas conversion plant for the Hugoton gas area of southwest Kansas by consulting engineer F. C. Koch, Wichita, who reports tentative agreements with both firms and individuals within the petroleum industry as co-sponsors. The Fischer-Tropsch process of direct molecular rearrangement of natural gas molecules into heavier hydrocarbons is to be used.

Initial step in the undertaking will be the acquisition of producing acreage for there is not an excess of production above that demanded by present transmission facilities. The BTU rating of Hugoton field gas is generally above 1050 although it carries a comparatively low natural gasoline content. There is no zone of sour gas in the Kansas area of production, therefore, making the source ideal for this type of conversion.

API Board Meeting

A MEETING of the Board of Directors of the American Petroleum Institute has been called for Thursday, December 7, at the Statler Hotel, Washington, D. C. President W. R. Boyd, Jr. announced that the setting of a date for the deferred Silver Jubilee meeting of the Institute in the spring of 1945 would be discussed at the meeting. Current and impending major problems of the industry and the relationship of the Institute to those problems will also receive detailed consideration. An all-day meeting of the board is contemplated, with a meeting of the executive committee in the evening. The meeting will follow a session of the Petroleum Industry War Council on December 6.

FOREIGN EMPLOYMENT

ARABIAN AMERICAN OIL COMPANY

GRADUATE CHEMICAL ENGINEERS FOR PETROLEUM REFINERY AS WELL AS OTHER HIGHLY QUALIFIED TECHNICAL REFINERY AND OILFIELD PERSONNEL required for Arabian American Oil Company's operation in Saudi Arabia. Engineers experienced in petroleum refinery design and operations desirable but not essential. Extensive training on refinery equipment will be provided before leaving the United States. Employment offers splendid opportunities for advancement and post-war security. Good working conditions, hospital and medical care, liberal benefit plans and vacation privileges in the United States. If genuinely interested in a foreign assignment, please send full information covering experience, references, transcript of college record, draft and availability status to our Relations Department, 200 Bush Street, San Francisco 4, California.

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Home front news is vital on the fighting front. Write a fighting man today.

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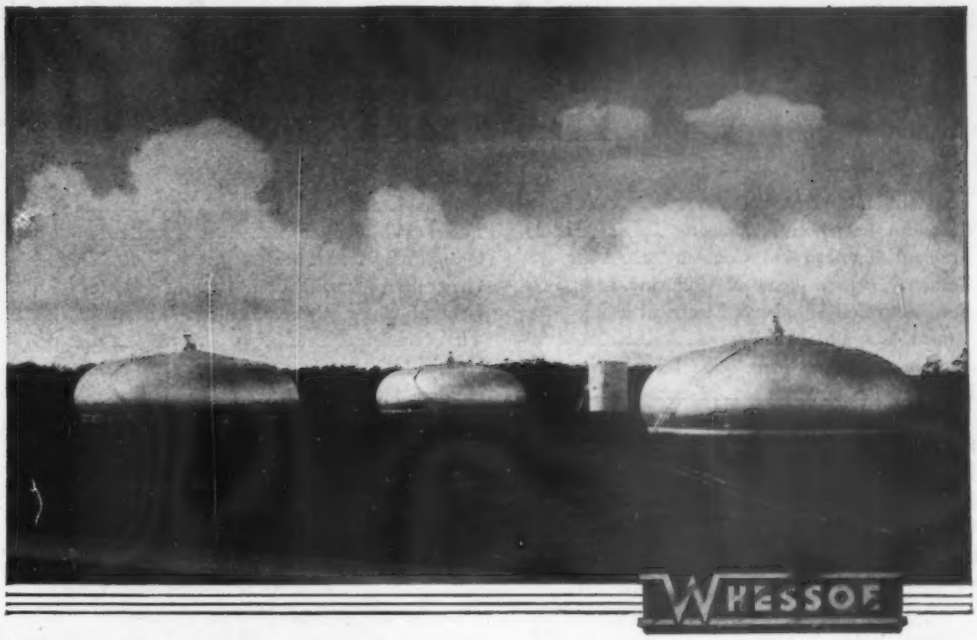

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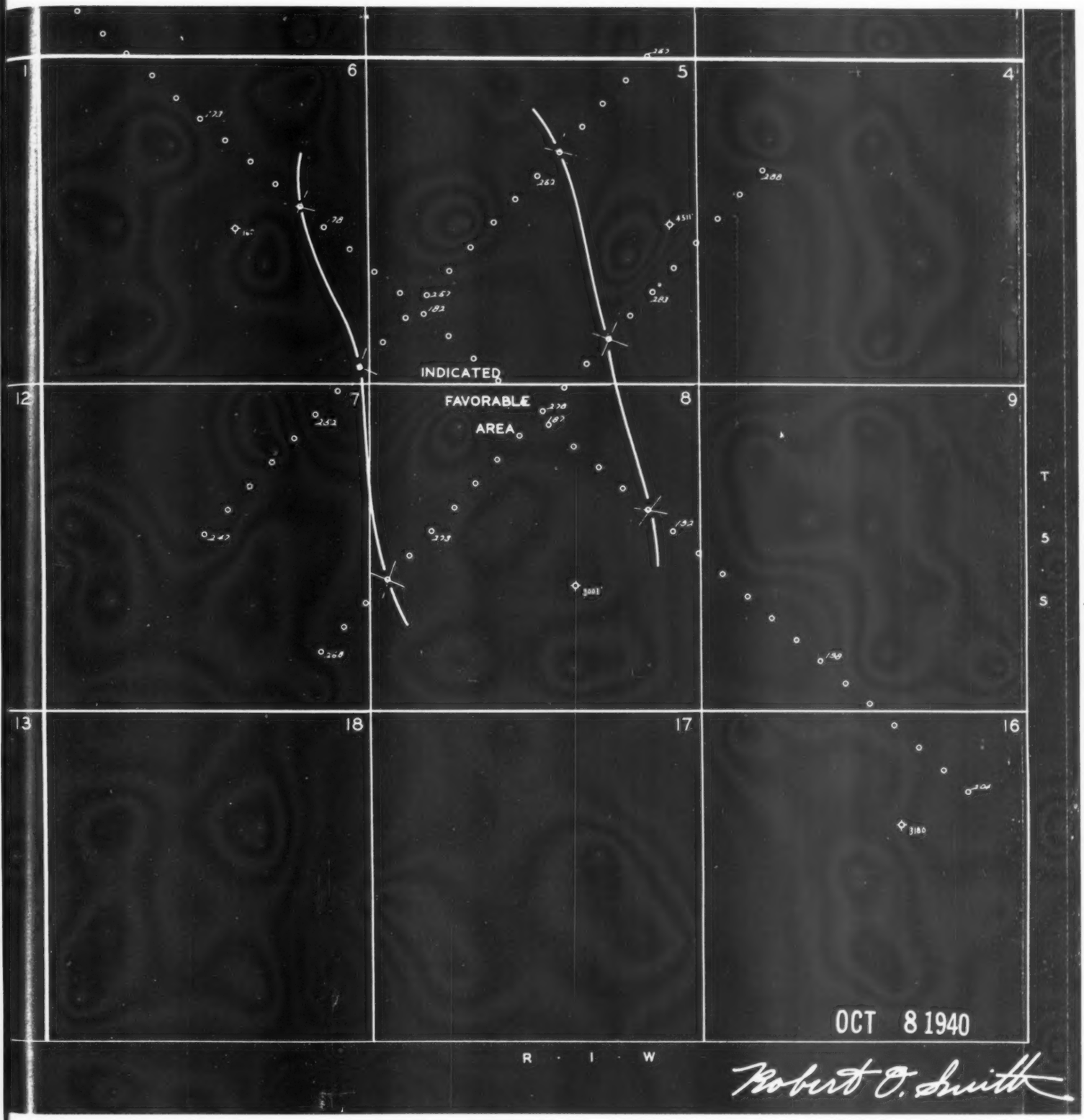
OCTOBER 8, 1940

BEFORE THIS AREA WAS DRILLED



THIS IS HOW OIL IS FOUND (1)

This portion of a Geochemical Survey was made southeast of the Hewitt Oil Field approximately 3 miles, in Carter County, Oklahoma. The small circles represent the soil sample locations. Also shown is our "Indicated Favorable Area." This map was completed Oct. 8, 1940.

This was a definite Geochemical Recommendation in advance of drilling.

*Any unauthorized use of the processes covered by our patents will be vigorously prosecuted. Licenses under these patents are available.

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While today the Smith System of Geochemical Surveying is much more detailed in lay-out pattern (100 soil samples to the square mile) which makes the over-all efficiency enormously greater, yet many former surveys done on the older "line" lay-outs (such as shown on this page) have been remarkably successful considering the scanty information then available.

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OCTOBER 8, 1944

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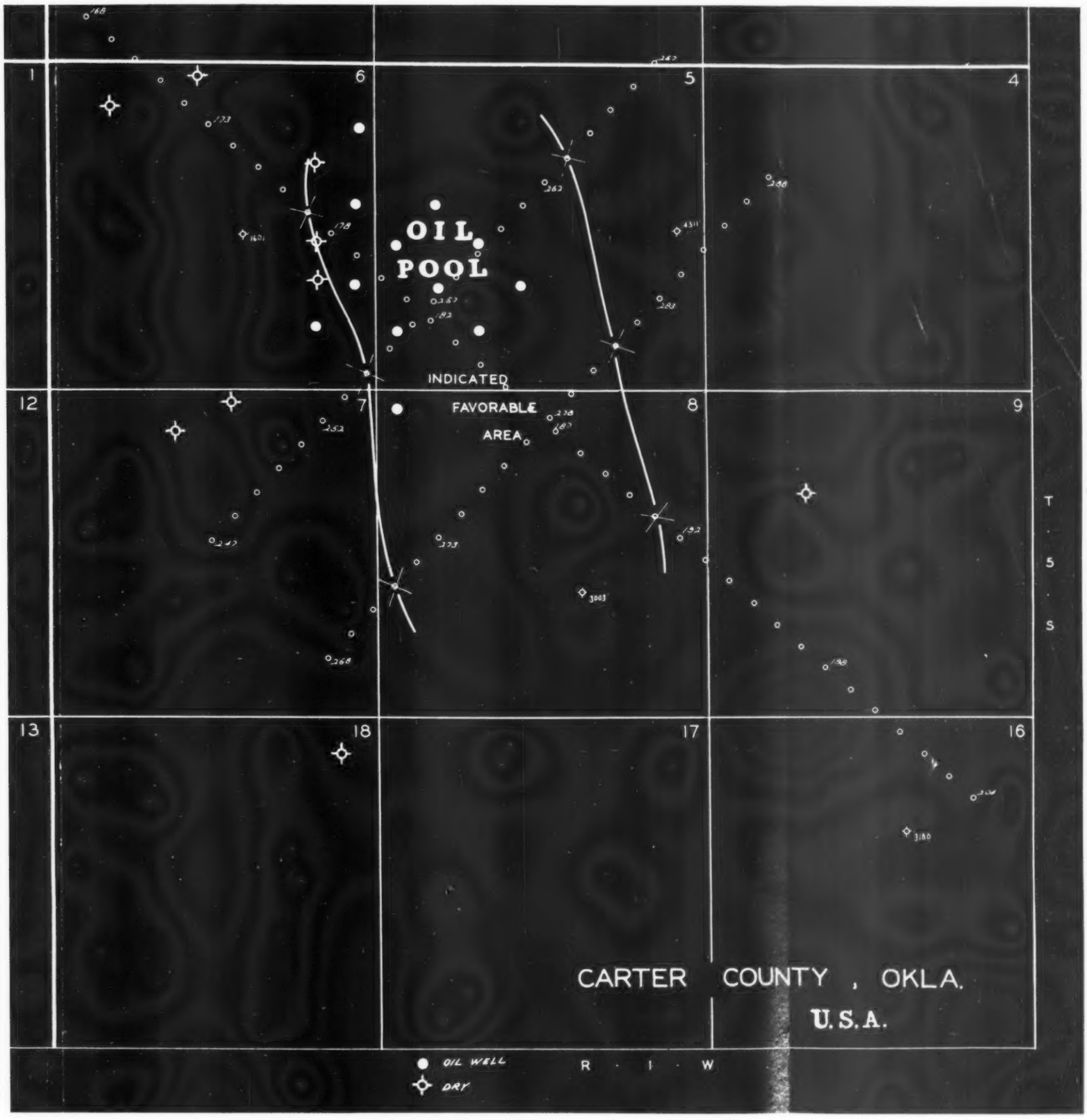

THIS IS HOW OIL IS FOUND (2)

Four years later. The same map with the present oil field partly drilled out, and also the dry holes which have subsequently been drilled.

It will be noticed that three dry holes are definitely on our western boundary, as marked out four years previously. Out of the 12 producers now in the field only one is just outside our indicated producing limits.

Such surveys as this, as well as the Storms Field, White County, Illinois, and the Walnut Bend Field, Cooke County, Texas, also done by this company, show that it is entirely possible to define the edges of an oil field with hair-line precision by the Smith System of Geochemistry before being drilled out.

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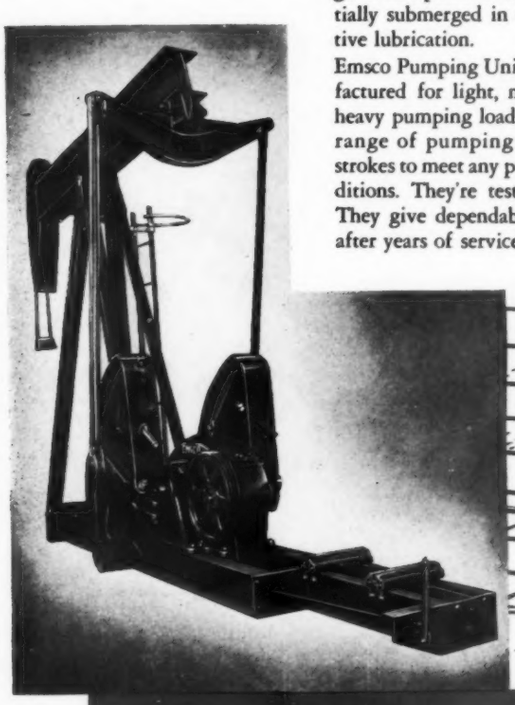

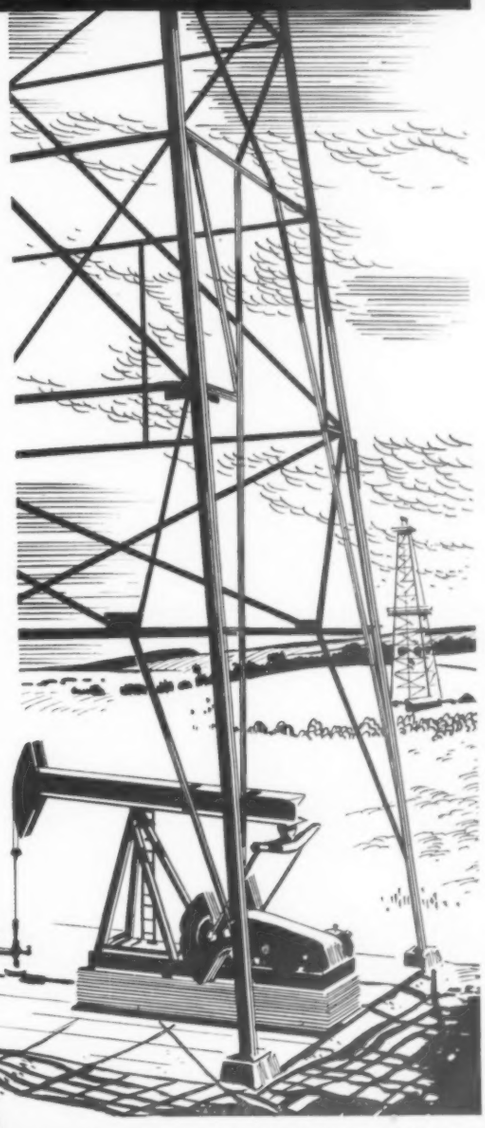

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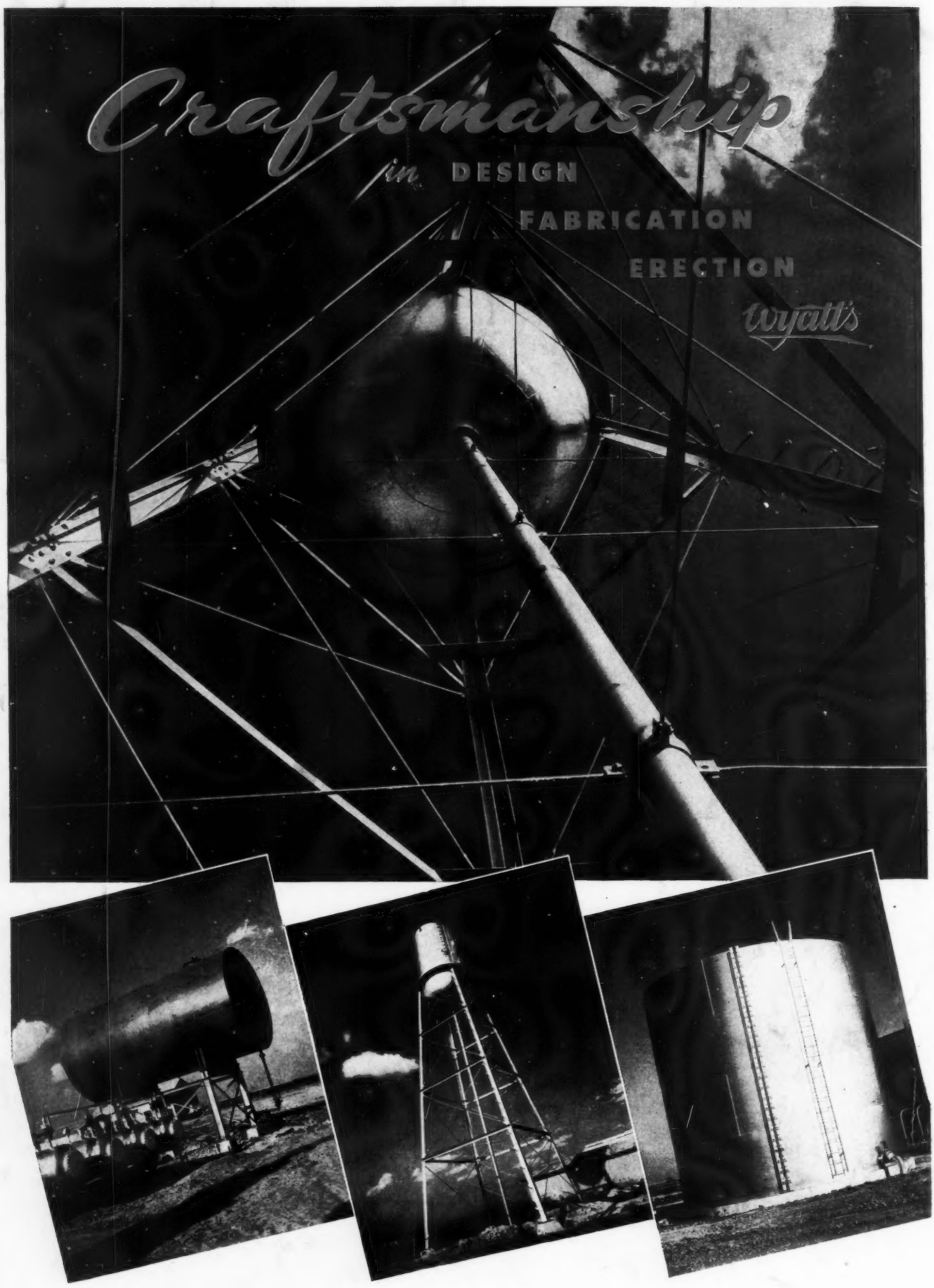
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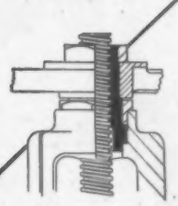

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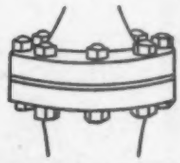

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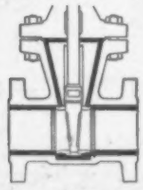

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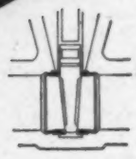

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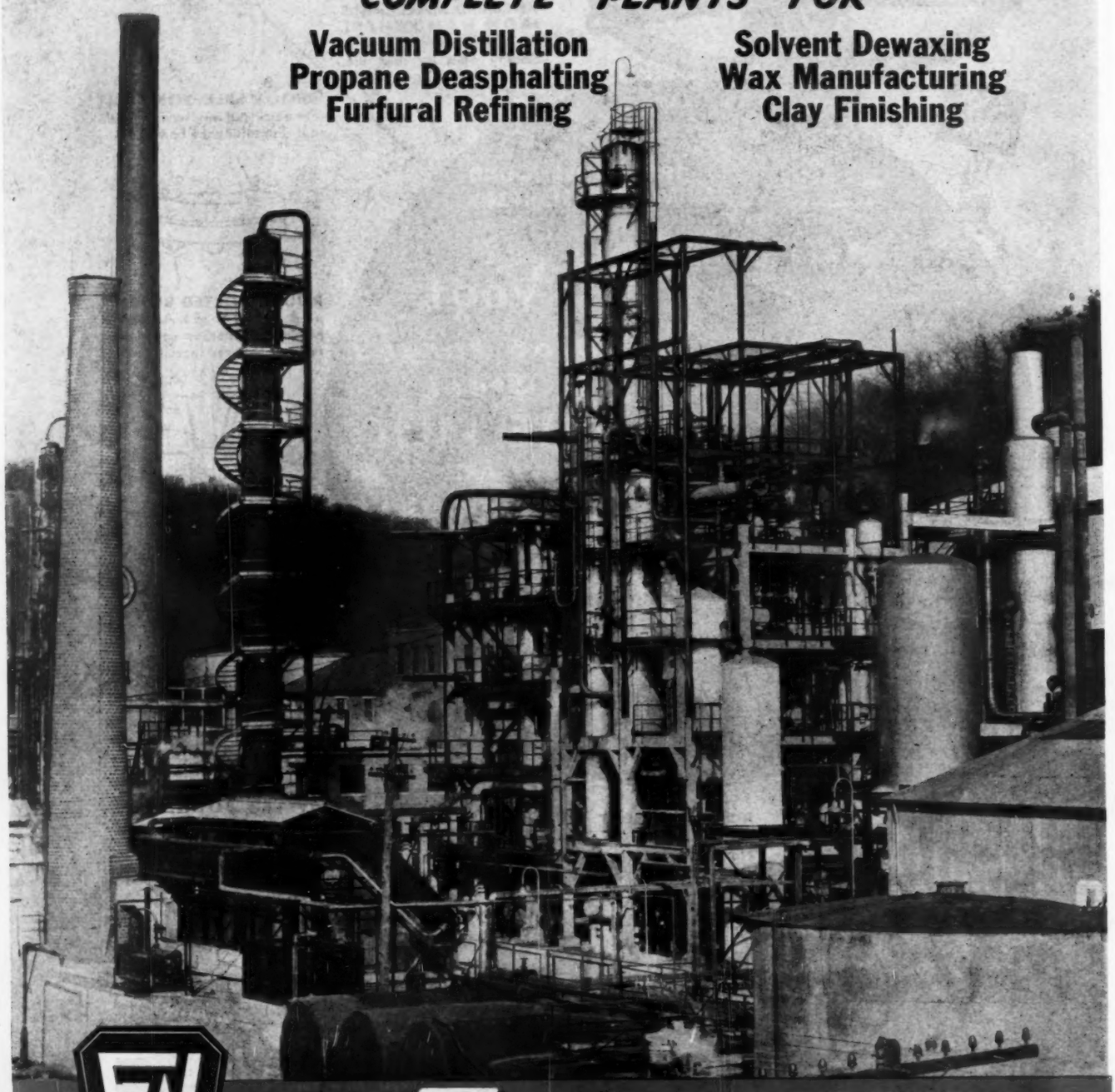

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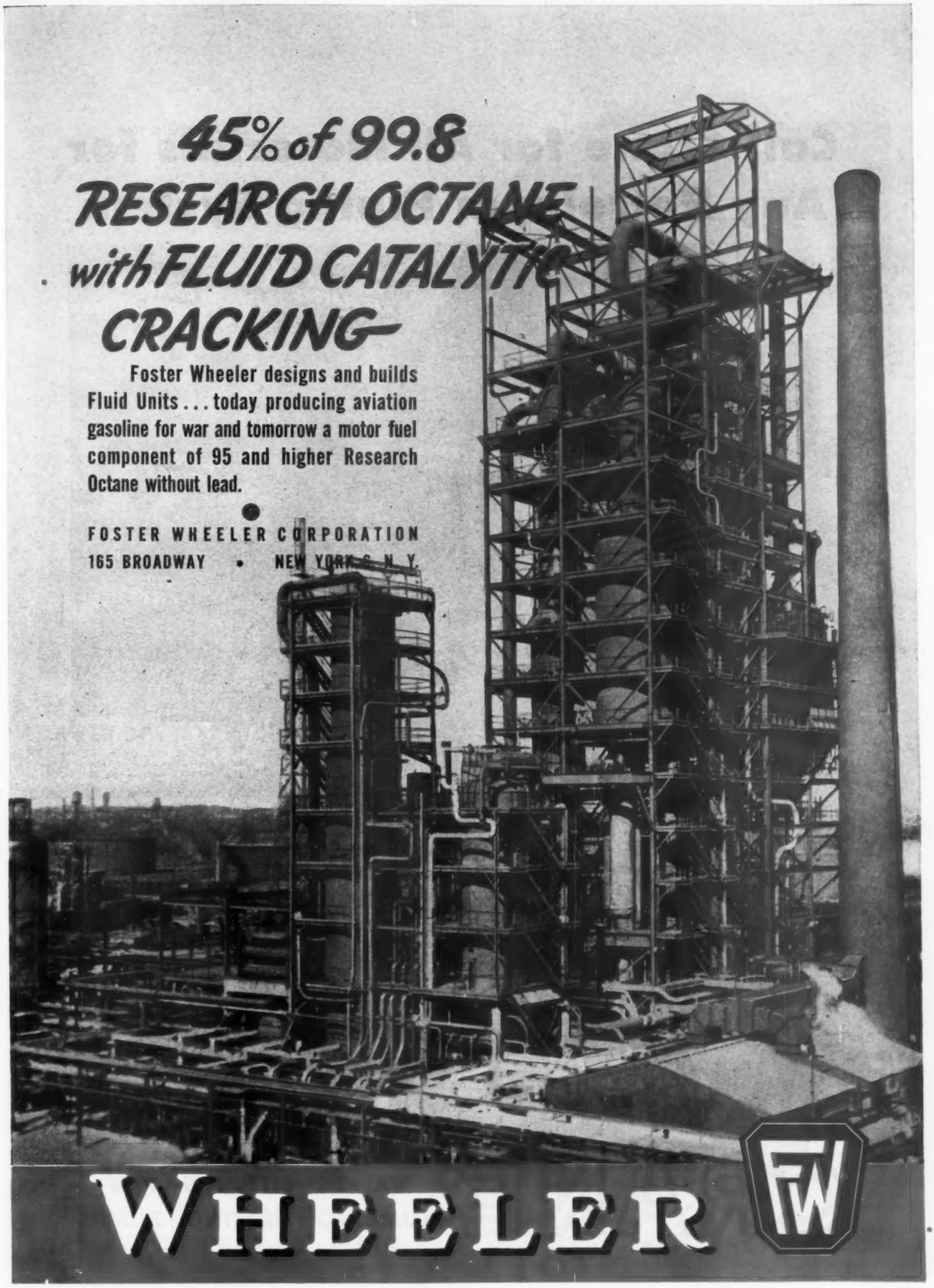
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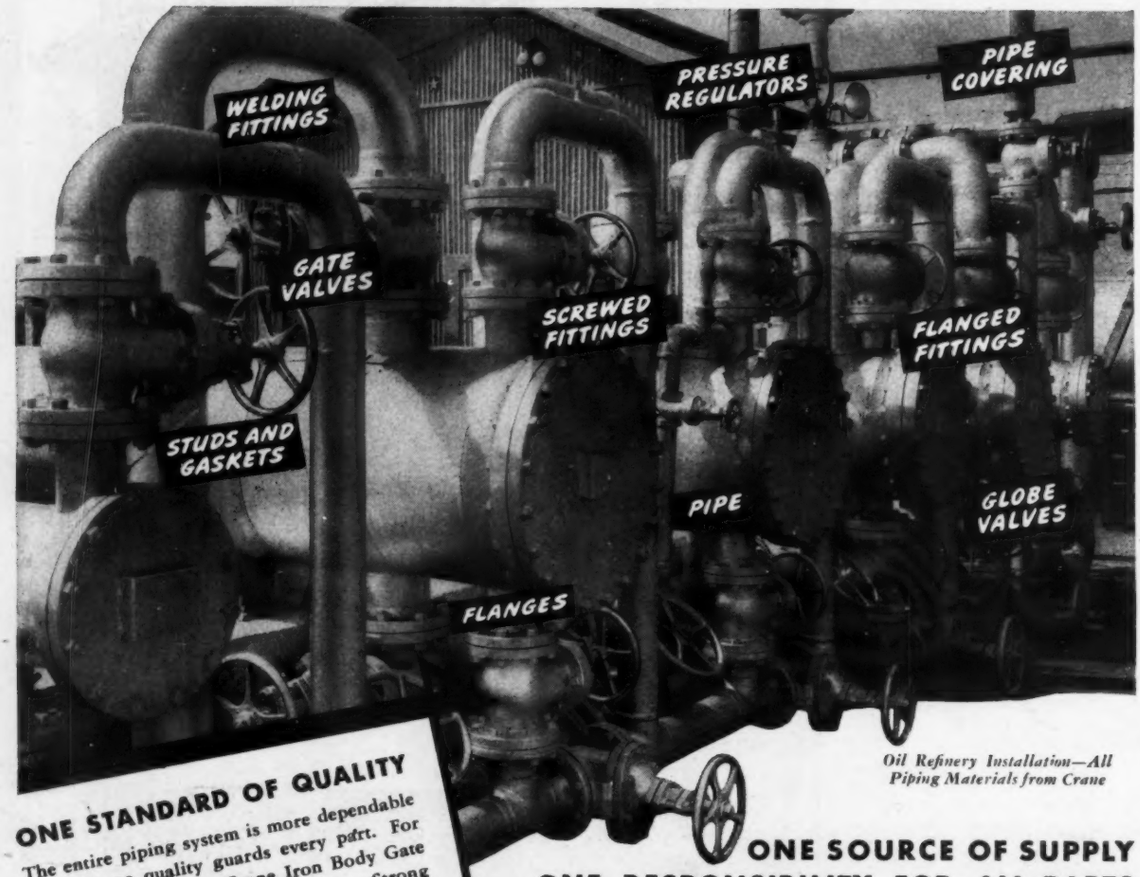

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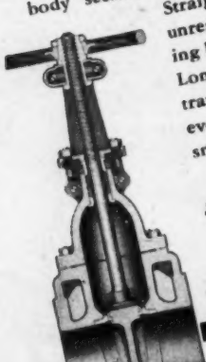

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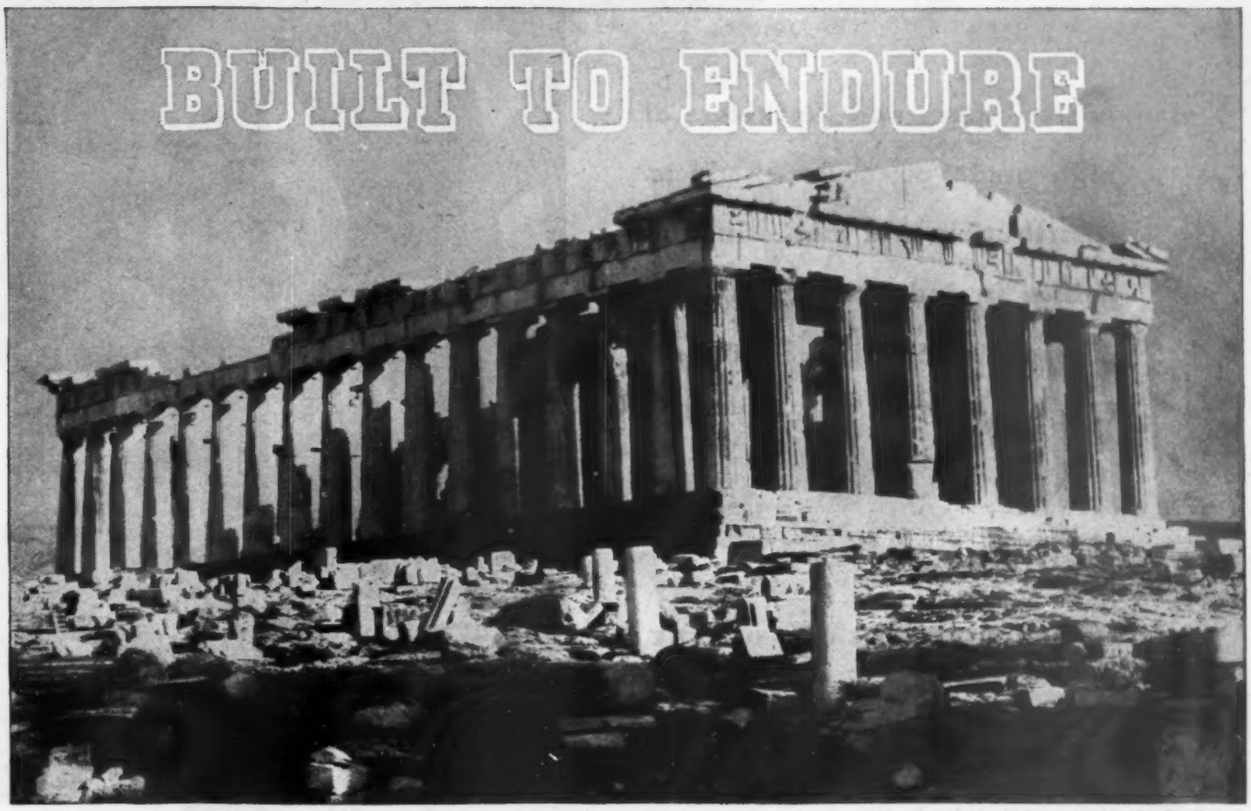

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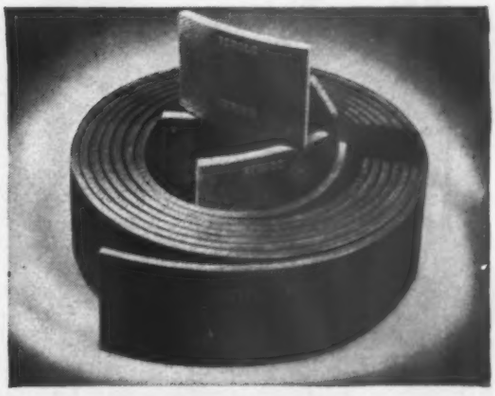

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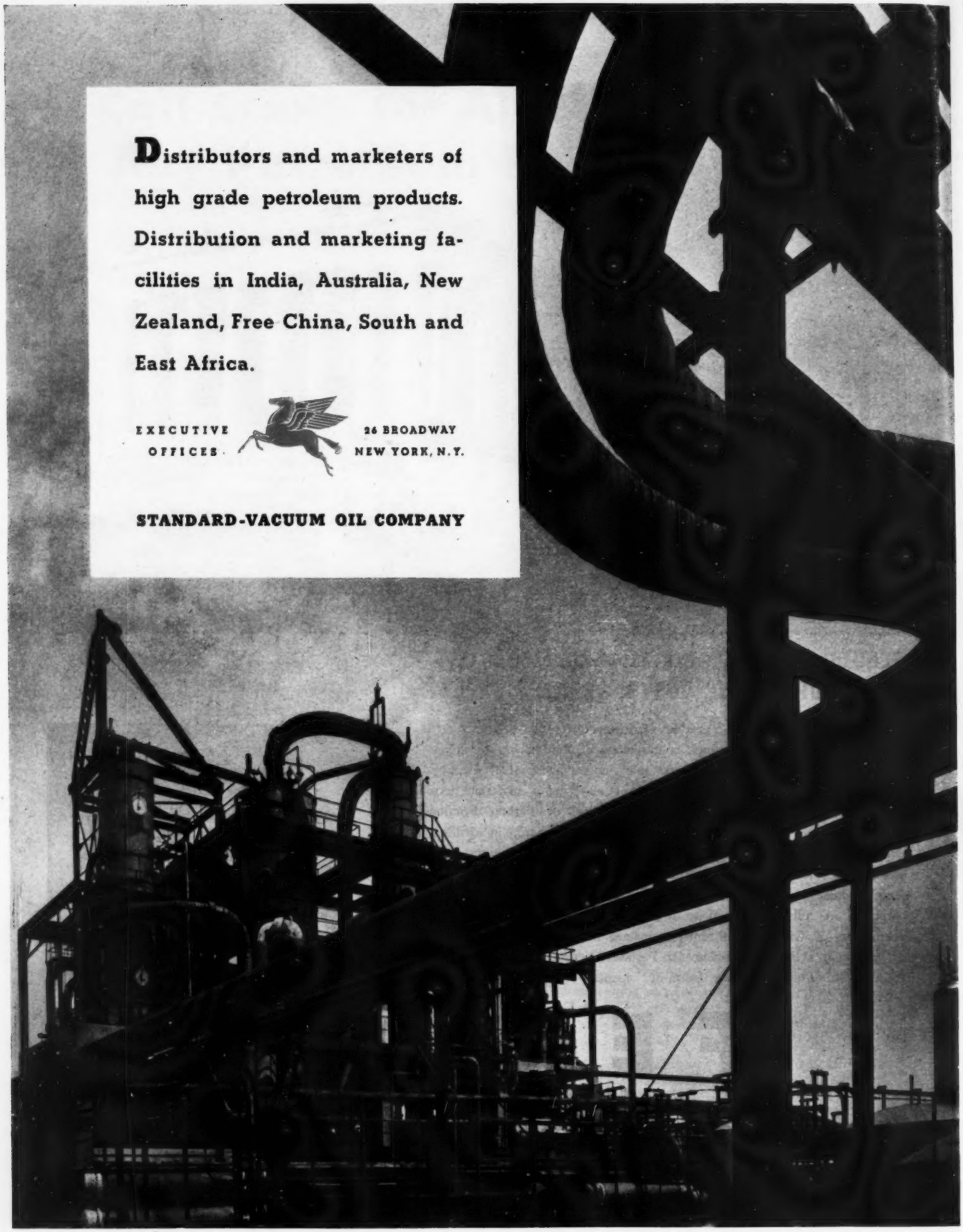
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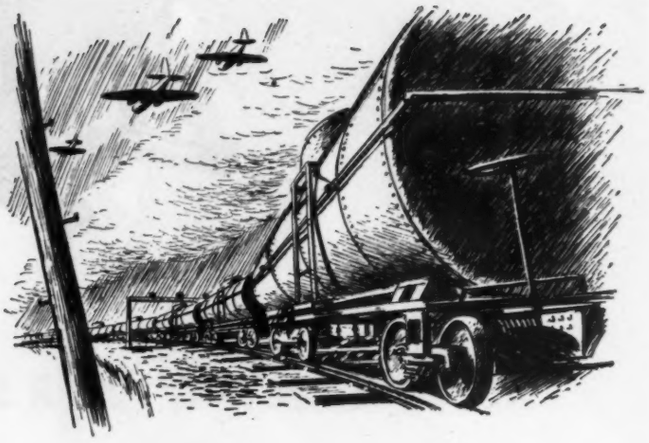

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Resisting a 3-Year Salt Attack

THIS Yoloy pipe has been in daily service in a corrosive salt atmosphere for over three years. It is the tail-water line handling condensate from the vacuum pan of a salt evaporator.

To the left you see the equipment "as is," encrusted with 3 years' accumulation of salt. Much of the piping, valves, tank, etc., is badly corroded.

Above is a closeup of the Yoloy pipe after the salt was removed. Note that it retains its perfection of threads, in fact, has the appearance of new pipe. That's because Yoloy is a nickel-copper steel, its remarkable ability to resist corrosion demonstrated in hundreds of instances like this.

Yoloy has many other valuable characteristics, too--extra strength, ability to withstand shock at low temperatures, great ductility, high weldability. Whenever you have the problem of selecting steel to meet adverse conditions, specify Yoloy. Yoloy is available now. Drop us a line ond our representative will be at your service.

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

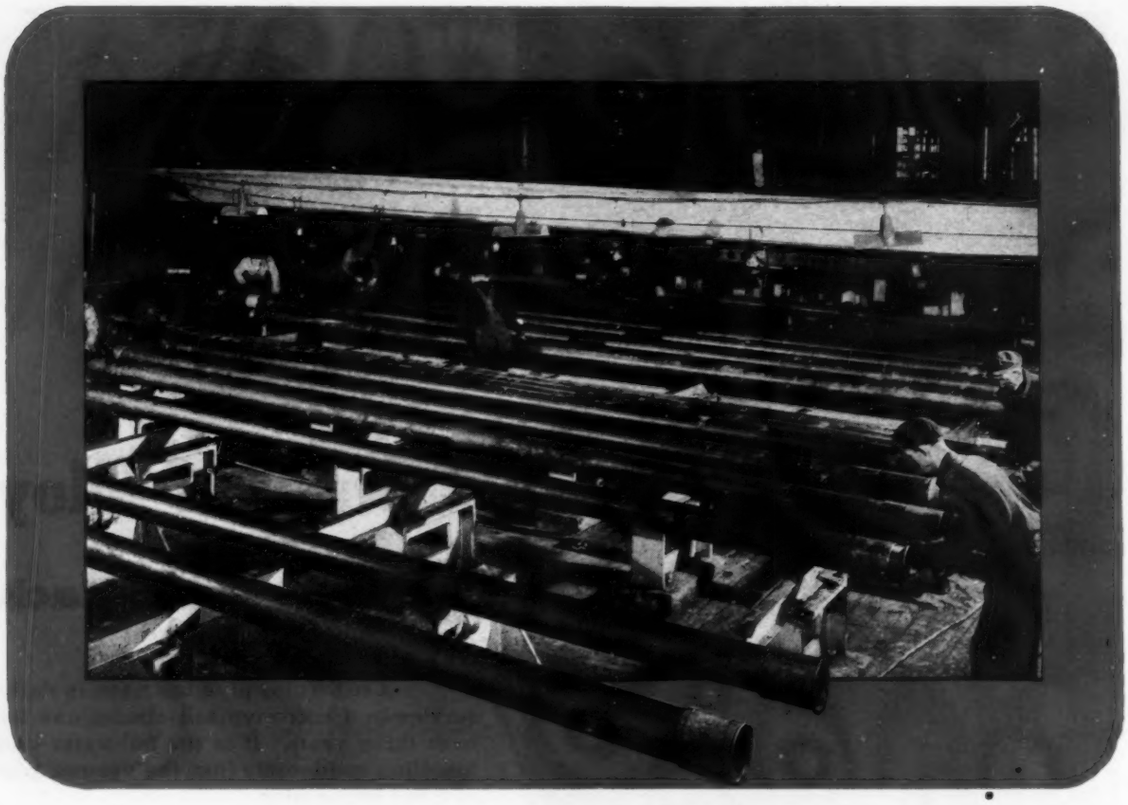
YOUNGSTOWN 1, OHIO

Manufacturers of

Carbon, Alloy and Yoloy Steels

YOLOY YOUNGSTOWN STEEL

Pipe and Tubular Products - Sheets - Plates - Conduit - Bars - Electrolytic Tin Plate - Coke Tin Plate - Rods - Wire - Nails - Tie Plates and Spikes - Alloy and Yoloy Steels.



EVERY LENGTH MUST PASS THIS FINAL EXAM

for better service in make-up and in the hole

New oil reserves must be found—in spite of limited steel supplies and scarcity of manpower. So, a casing that makes up fast and stands up in service is a *demand item.*

Republic Casing meets those requirements 100%—as demonstrated by more than 50,000,000 feet of Electric Weld Casing and Tubing in service throughout the world.

The rigid final inspection of Republic Casing, shown above, is one of many procedures that mean better casing for you. It helps produce casing that saves time at every joint—that stabs, spins-in and tongs-up uniformly—that is armed with high pull-out and collapse strength.

If you want better service in field and refinery operations, demand Republic Alloy Steels—Sheets and Plates—Electric Weld Line Pipe—Electrunite Heat Exchanger and Condenser Tubes—Upson Studs, Bolts and Nuts.

With more and more oil country men specifying these products because of their records of field performance, Republic has taken a front rank position among the Petroleum Industry's suppliers.

REPUBLIC STEEL CORPORATION

Export Department:
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Berger Manufacturing Division • Culvert Division
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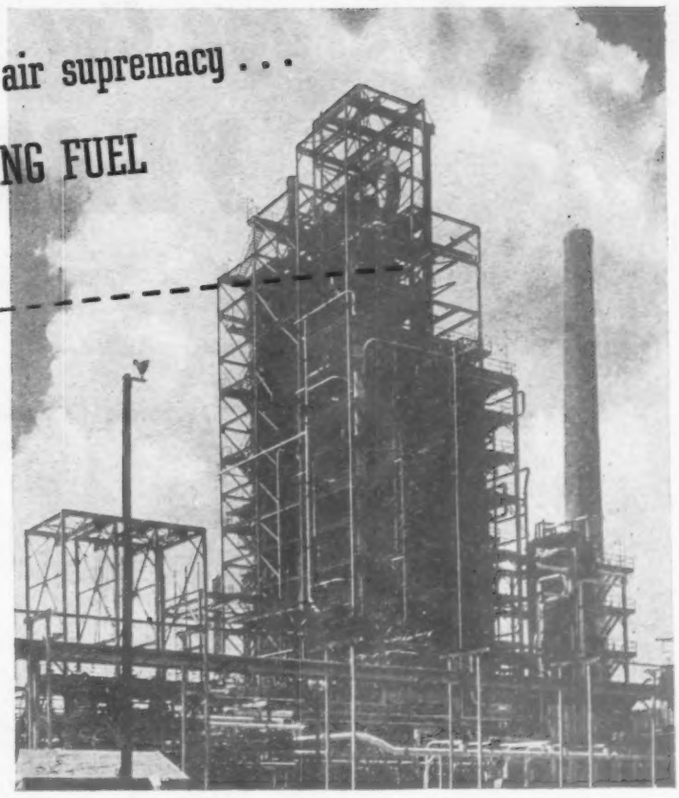
Union Drawn Steel Division • Truscon Steel Company

REPUBLIC *Electric Weld*
LINE PIPE
NORMALIZED CASING AND TUBING

Towers of American air supremacy . . .

Birthplace of FIGHTING FUEL



SOLVAY

TRADE MARK REG. U.S. PAT. OFF.

49-50%

tank car

LIQUID

CAUSTIC POTASH

★ **LIQUOR**
(49-50% KOH)
Shipped in tank cars—
10,000 gallons.

★ **SOLID**
(90% minimum KOH)
Shipped in steel drums
700 lbs.

★ **FLAKE**
(90% minimum KOH)
Shipped in steel drums—
350 lbs.

Gasoline powers the attack! . . . and helping to give high octane gasoline its fighting power is SOLVAY LIQUID CAUSTIC POTASH.

Produced with a KOH content of approximately 50%, it meets the needs of refiners for a high quality alkali with *an absolute minimum of impurities.* Prompt shipments in tank cars from our Syracuse plant.

Solvay can meet your requirements . . . Write today!

SOLVAY SALES CORPORATION

Alkalies and Chemicals Products Manufactured by The Solvay Process Company

40 RECTOR STREET NEW YORK 6, N. Y.

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INVESTED IN HIS TRAINING *MORE GASOLINE* THAN

The Average Car Uses in...

18 YEARS!

The training of ONE pilot represents an investment of as much gasoline as the average car uses in 18 years . . . . The fuel tanks of ONE B-29 hold 8,000 gallons of gasoline—the approximate equivalent of the capacity of an average tank car . . . In ONE four-hour mission, 1000 Flying Fortresses will consume 400,000 gallons of gasoline.

Do you wonder why military needs of gasoline have jumped from 6.7% of total consumption in 1941 to an estimated 40% of the total today? Do you wonder why honest enforcement of rationing restrictions is necessary to forestall much more drastic regulations? And do you blame us for being proud of the privilege of having supplied the pumps that move the fuel of war through portable pipe lines to fighting fronts throughout the world? . . . Gaso Pump & Burner Mfg. Co., 902 East First Street, Tulsa, Oklahoma. Export Office: 149 Broadway, New York. Shreveport: W. L. Somner Co., 419 Lake Street. Los Angeles: Service Oil Field Supply Co., 5333 S. Riverside Drive.

GASO FOR EVERY OIL INDUSTRY NEED

Pumps fuel to fighting fronts!

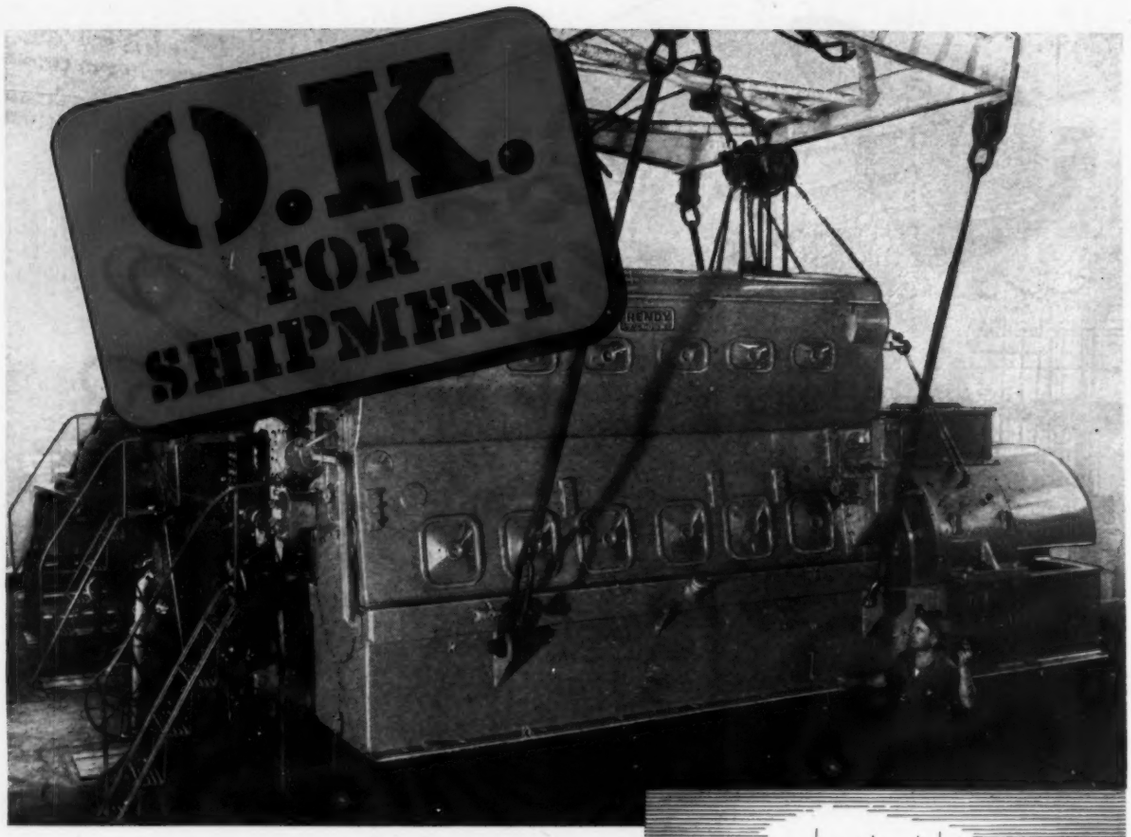
THE BLACK MARKET IS A PLAGUE that drains 2,500,000 gallons of gasoline a day from legitimate channels. It thrives on customers willing to sacrifice the nation's welfare to their own selfish convenience. Without such customers it would die overnight.

Like most people these days, we find ourselves spending a lot of time on problems which affect the war effort in some way or other. But we don't want to make a fuss about that. It's true that our method of moulding brake linings on cylindrical drums has been of great service to the aircraft industry, and by finding a way of cementing friction material to metal without using rivets or similar means of fastening we made ourselves very useful to certain people who make superchargers for aircraft engines. In the belting field, as well, we've kept a jump ahead of developments, particularly with woven endless belts, which are a cure for many industrial headaches. The point is that when it comes to belting of all kinds, asbestos products, friction materials, brake and clutch linings, packings or jointings we're not just manufacturers. If you use any of these things you'll find that we've got the answer to most of the problems which crop up from time to time and if we haven't, well . . . we like hard nuts to crack.

BRITISH BELTING & ASBESTOS LIMITED

CLECKHEATON (YORKS) AND LONDON

Spinners, weavers and manufacturers of Asbestos yarns, cloths, tapes, packings and jointings; manufacturers of Machinery Belting for all industrial purposes; manufacturers of "Mintex" Brake and Clutch Linings and other friction materials



Now "DIESELS by HENDY" for the Maritime Commission

AV1 Cargo Ship

To the long list of Hendy products built for the Maritime Commission in the past few years is now added *Diesel generating sets*... of a *new* and *advanced* type. Coming off the production line in a steady stream, these 250-kw plants for the AV1 Cargo Ships are another example of Hendy's ability to design, produce and deliver—to combine precision workmanship with mass production.

The experience gained in building the engines for over one-third the entire Liberty Ship Fleet...the 4000-, 6000- and 8500-hp turbines and reduction gears for cargo and hospital ships... and turbo-generators of many types, made possible the remarkable delivery record of these Hendy Diesel generating plants.

Hendy Series 50 Diesels are available for industrial applications as prime movers, or with Crocker-Wheeler generators as a-c or d-c generating plants up to 450-kw in size. Orders are now being accepted for early deliveries. Write for complete information, stating your power requirements.

WRITE FOR DATA ON THE HENDY SERIES 50 DIESEL

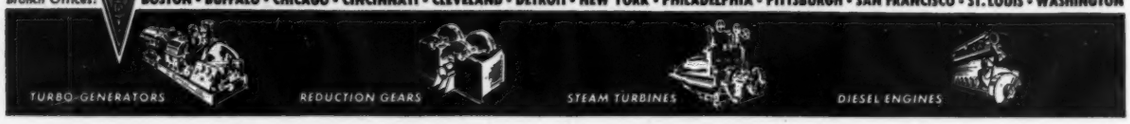
375 to 675 hp

This modern Diesel offers 22 proved features in design never before available in a single engine. Direct-actuated dual valves, unit-type fuel injectors, overhead camshaft, hydraulic tappets and oil-cooled pistons are just a few of them. You, as a Diesel operator, will appreciate these and the others—for, combined, they are responsible for the high operating efficiency of Hendy Diesels. Catalog available on request.

JOSHUA HENDY IRON WORKS
ESTABLISHED 1856
SUNNYVALE, CALIFORNIA

91-B-11

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • ST. LOUIS • WASHINGTON



Control that Assures Uniformity

OPERATING a high-capacity foundry and heat treating plant, in combination with a modern metallurgical laboratory, guarantees to Axelson the complete control of product uniformity right from the start.

In the production of Axelson Deep Well Plunger Pumps, every phase of designing, engineering and manufacturing, from raw materials to precision assembly, is completed under one roof. Because no operation is farmed out, there is no compromise in quality—even in the smallest detail.

This control assures longer life, better performance and greater customer satisfaction. It is one more reason why hundreds of pump operators place so much confidence in Axelson equipment—and continue, year after year, to specify "Buy Axelson."

Users of Axelson Deep Well Plunger Pumps and Sucker Rods profit not only by these controlled manufacturing processes, but also by Axelson's years of precision pioneering in the development of better products for the petroleum industry. All Axelson products have been accepted as the best of their kind because, in half a century, Axelson has never deviated from the principle, "There is no Economical Substitute for Quality."

AXELSON MANUFACTURING COMPANY

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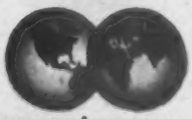
AXELSON

ORIGINATORS OF

INTERCHANGEABLE LINER PUMPS



FOR INTERNATIONAL SERVICE

...HOW TO *save weight material and fishing jobs*

The PATTERSON-BALLAGH PIPE WIPER has many benefits. The two most important mean the saving of costly mud weight material and many fishing jobs. It is easily installed under the master bushing. When the pipe is pulled from the hole, the mud or oil is "squeegeed" from the pipe. So completely is it removed that *no wash water is needed.* Therefore, there is *no* dilution of the mud. This means a saving in weight material, clean pipe and floor.

See Composite Catalog

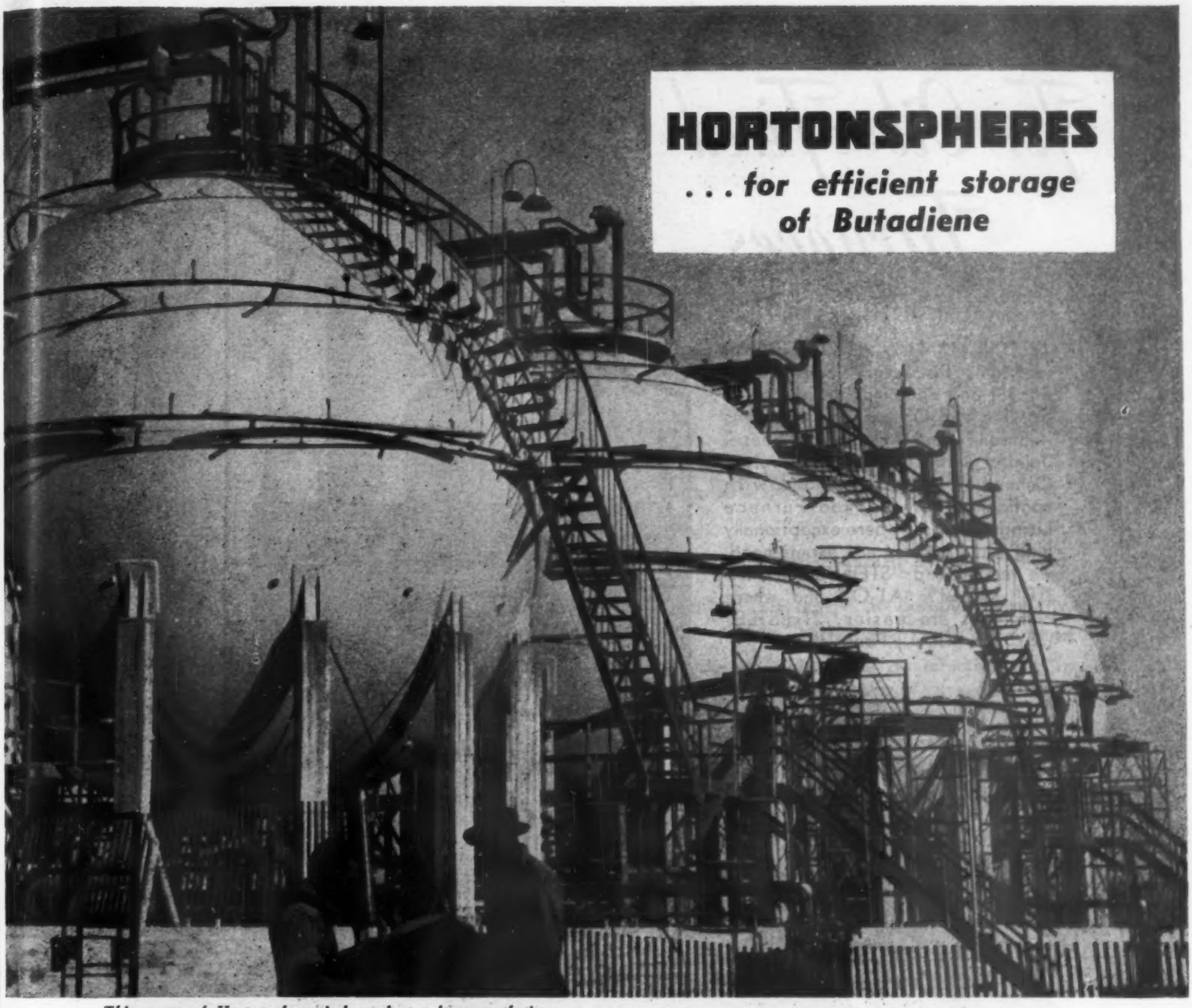
As the disc is steel-reinforced, one-piece and of large diameter, the hole is effectively protected against the dropping of small items such as broken slips, tong dies, hammers, chisels, etc., which are constant fishing hazards.

In addition, the rig is safer because the floor is not muddy or greasy; drill pipe is easier to handle; tubing is easier to inspect; "channeling" is reduced and spinning rope does not become waterlogged.

The PATTERSON-BALLAGH PIPE WIPER, now made of PBX synthetic rubber, resists the corroding effect of oil and weather.

PATTERSON-BALLAGH
Los Angeles 1 • Houston 10 • New York 6

PATTERSON-BALLAGH PIPE WIPERS



This group of Hortonspheres is located at a large synthetic rubber plant. Each sphere is 29½ ft. in diam. holds 2400 bbls. and is designed to operate at 100 lbs. per sq. in. pressure. At this plant light hydrocarbons from a nearby refinery are converted into butane-butylene fractions and are used in making butadiene.

The problem of handling and storing butadiene may be efficiently solved with Hortonspheres. These high pressure storage tanks possess advantages which make them desirable for storing many highly volatile products. The basic operating principle of Hortonspheres enables these vessels to prevent evaporation loss from the products stored therein. They are designed to withstand pressures built up in the vapor space at normal temperatures without venting. By preventing evaporation Hortonspheres also minimize product deterioration, resulting from excessive evaporation.

Some of the other fundamental advantages of the Hortonspheres are:

1. *Economical* — The spherical shape utilizes material to the best advantage.
2. *Dependable* — No machinery or moving parts to get out of order.
3. *Low Fire Hazard* — Vapor space in sphere is saturated at all times, thus explosion or ignition is virtually impossible.
4. *Minimum Corrosion* — Oxygen is rarely present in a Hortonsphere, hence the inside of the shell does not corrode readily.
5. *Hortonspheres* are built in standard capacities of from 1,000 to 20,000 bbls. for pressures from 20 to 100 lbs. per sq. in.

CHICAGO BRIDGE & IRON COMPANY

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In Canada: Horton Steel Works, Limited, Fort Erie, Ont.

For Oil-Fired Furnaces

NETTLE (42/44% Al_2O_3) Firebrick is Highly Refractory (Seger Cone 34/35) and combines Resistance to Spalling and Corrosion with volume —Stability and Accuracy of Shape. Jointed with "NETTLE" Refractory Cement, it is recommended with confidence for Oil-Fired Furnace Linings. In cases where exceptionally high temperatures are experienced, we recommend "STEIN SILLIMANITE" (62/63% Al_2O_3) and where conditions are easier, "THISTLE" (35/37% Al_2O_3) Firebrick.

STEIN *Refractories*

JOHN G. STEIN & CO. LTD. BONNYBRIDGE, SCOTLAND

FIBROTEX

A SUPERIOR FIBROUS MATERIAL FOR RESTORING LOST CIRCULATION

FIBROTEX is one of several specialized Baroid Products available for special problems.

FIBROTEX is added to rotary mud to prevent or restore lost circulation in gravelly, fractured, or creviced formations and is far superior to the beet pulp, cottonseed hulls, straw and other materials commonly used. It will form an effective seal in many types of formations which previously required a cement job.

FIBROTEX is economical. One bale will treat about four barrels of mud, and 50 barrels of mud are often sufficient to prevent further loss. A large supply occupies minimum space and it does not deteriorate in storage.

BAROID PRODUCTS:

ANHYDROX • AQUAGEL • AQUAGEL CEMENT • BAROCO • BAROID • FIBROTEX
IMPERMEX • MICATEX • SMENTOX
STABILITE • ZEOGEL • TESTING EQUIPMENT
BAROID WELL LOGGING SERVICE

PATENT LICENSES, unrestricted as to sources of supply of materials, but on royalty bases, will be granted to responsible oil companies and operators to practice inventions of any and/or all of United States Patents Numbers 1,807,082; 1,991,637; 2,041,086; 2,044,758; 2,064,936; 2,094,316; 2,119,829; 2,214,366; 2,294,877; 2,304,256 and further improvements thereof. Applications for Licenses should be made to the Los Angeles office.

BAROID SALES DIVISION

NATIONAL LEAD COMPANY

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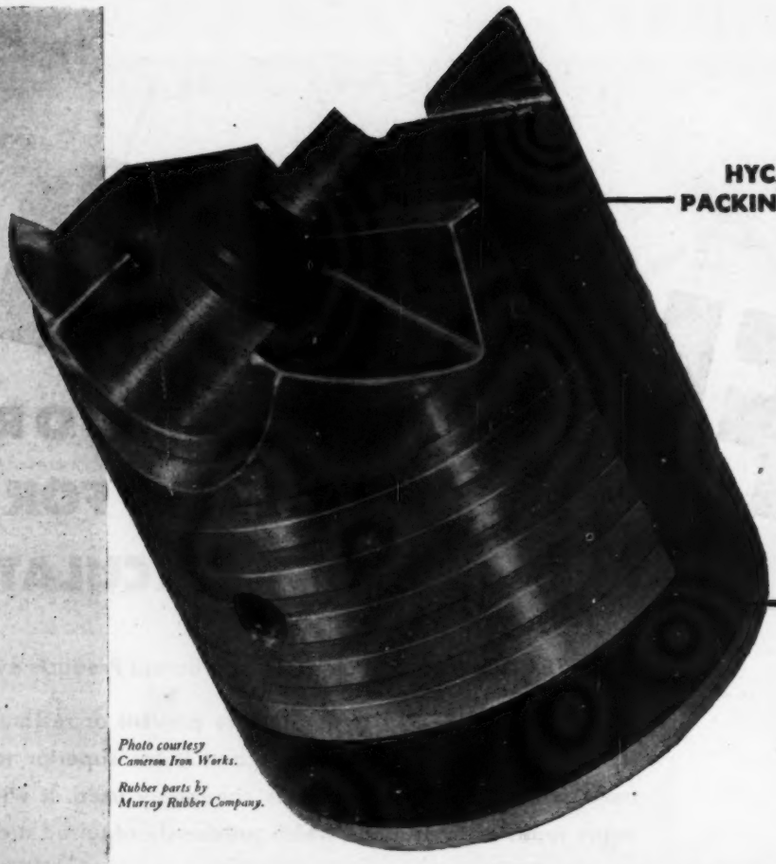


Photo courtesy Cameron Iron Works.

Rubber parts by Murray Rubber Company.

HYCAR PACKINGS PREVENT WASTEFUL OIL WELL BLOWOUTS

Resist oil and abrasion to give positive seal against high pressures

As nearly every oil man knows, many wells drilled below 10,000 feet in recent years have depended on Cameron Blowout Preventers to eliminate the chance of costly, dangerous blowouts like the one in the picture. But it may not be so well known that the self-feeding ram packing element in the Cameron preventer is made of Hycar synthetic rubber.

There's a reason behind the selection of Hycar for this severe service. Certain properties —in just the right combination—are essential: Oil and gas resistance, to prevent deterioration and weakening of the packing; abrasion resistance, to stand 6 or 8 hours rotation of the drill pipe while weighting material is being added to the drilling mud; permanent resilience, to provide a positive seal when the need suddenly arises as a high pressure zone is penetrated.

Hycar provides these properties—*and in just the right combination.* Other properties are listed in the box at the right. That list will tell you why Hycar has so many oil field applications—gate packers in mudline valves, casing head seals, gaskets of all kinds, drilling and suction hose, and many others.

Ask for parts made of Hycar. Test them yourself in your own tough applications. Learn for yourself that Hycar can help reduce operating costs—that it's wise to use Hycar when the going gets tough. *Hycar Chemical Company, Akron 8, Ohio.*

WHAT HYCAR DOES IN OIL FIELD APPLICATIONS

1. Resists oil and gas—even under high pressure.
2. Resists action of abrasive-laden fluid under high pressure and at high velocity.
3. Wears at slow rate even under worst conditions.
4. Makes a positive, leak-proof seal, even after a long period of service.
5. Provides high elasticity.
6. Gives high tensile strength.
7. Has minimum tendency to cold flow and compression set.

Hycar

Reg. U. S. Pat. Off.

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

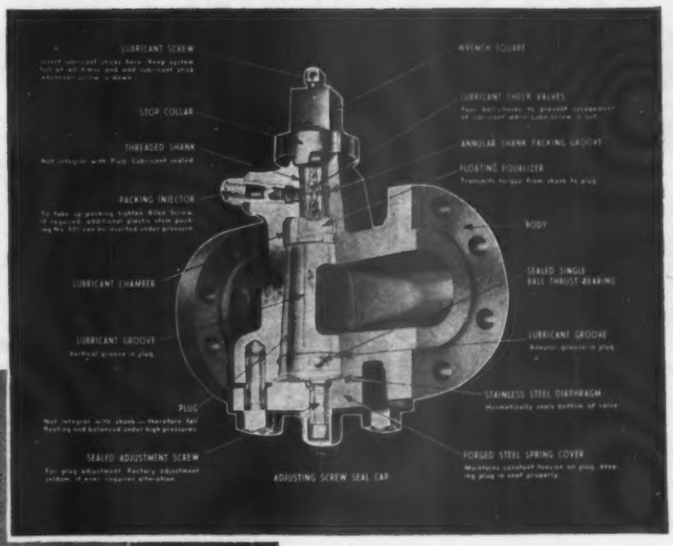
Synthetic Rubber

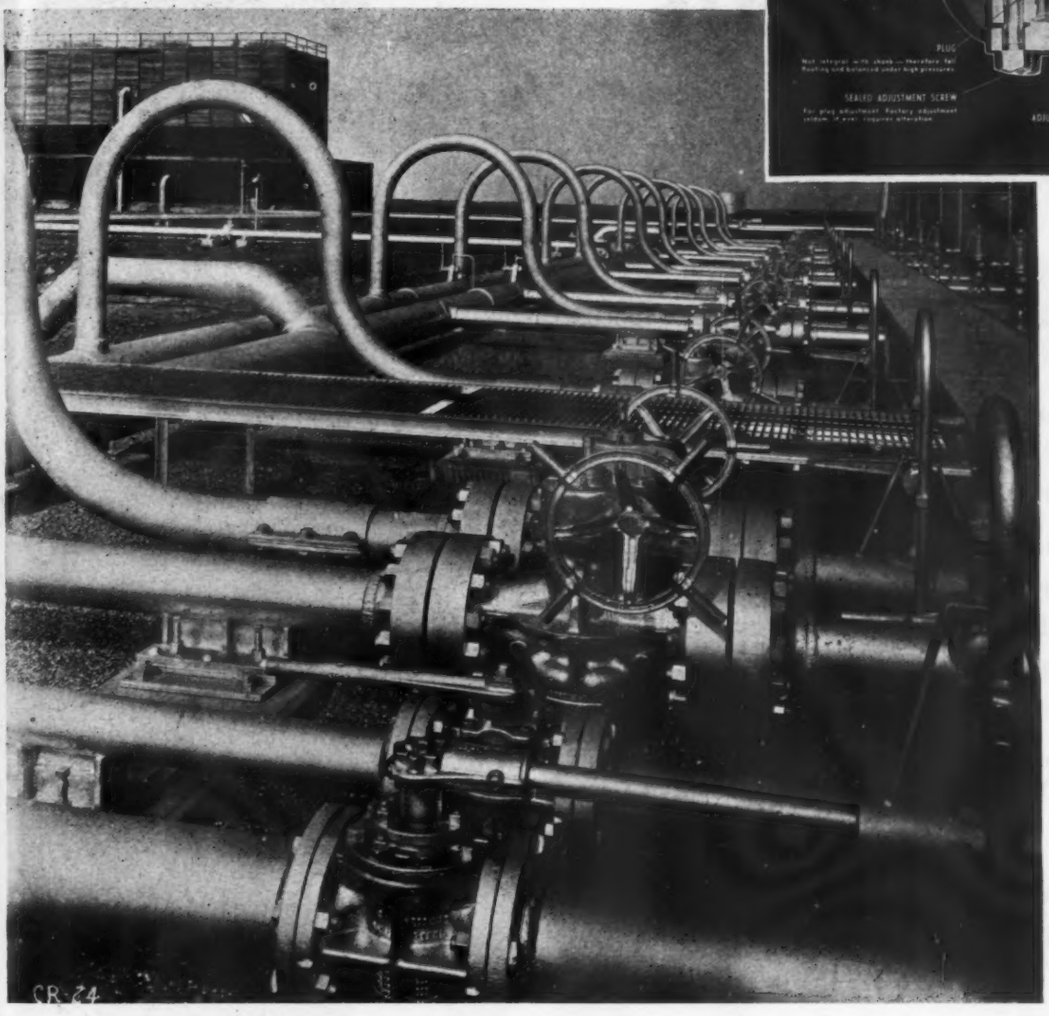
Free—write for your copy of the new pocket-size Hycar Glossary of commonly used synthetic rubber terminology.

No leaks in these valves

Lubrication seals the ports

Highest pressures controlled safely





HYPRESEAL TYPE

FEATURES OF AUDCO-NORDSTROM VALVES

Tapered plug with lubricated seat.

Pressure sealed by hydraulic application of lubricant.

Sealed ports. Lubricant forms a positive seal around each port.

Shoulder stem seal, used in place of conventional stuffing box, producing minimum friction.

Easy to turn. Lubricant forms a bearing film between plug and body.

Resistant to corrosion and erosion. Protected by pressure lubricant. Seat is unexposed.

Highest pressures successfully handled.

Keep Upkeep Down

AUDLEY ENGINEERING COMPANY Ltd.
Newport, Shropshire, England

SOUTH AFRICA: Fraser & Chalmers (S.A.) Ltd., Cullinan Building, Corner Main and Simmonds Streets, Johannesburg • AUSTRALIA: Noyes Bros. (Sydney) Ltd., 115, Clarence Street, Sydney • Noyes Bros. (Melbourne) Ltd., 597-603, Lonsdale Street, Melbourne, C. I. • SOUTH AMERICA: The Armco International Corporation, Buenos-Aires, Rio de Janeiro, Sao Paulo, Ancon (Canal Zone) • MEXICO: Fundicion De Fierro De Torreon S.A., Torreon, Coah, Mexique • CANADA: Peacock Bros. Ltd., Montreal, Quebec.

MERCO NORDSTROM VALVE COMPANY
A Subsidiary of Pittsburgh Equitable Meter Co.
400 N. LEXINGTON AVE., PITTSBURGH 8, PA.

Branches: Atlanta, Boston, Brooklyn, Chicago, Houston, Kansas City, Los Angeles, New York City, Oakland, San Francisco, Seattle, Tulsa.

AUDCO-NORDSTROM

BRITISH AMERICAN

LUBRICATED VALVES

They live on dreams

Rice. That's what our boys in the Japanese prison camps eat.

They get it for breakfast, garnished with taunts. For lunch, seasoned with threats. For dinner, covered with verbal abuse.

Twenty thousand Americans, day after day, week after week, month after month until they are liberated, will live on this fare. Twenty thousand—and more.

But it is more than rice that they live on. For they live on dreams. Dreams of hearing, one day, the guns of the American battle squadrons drawing nearer. Dreams of hearing in the sky the thunder of American planes. Dreams of hearing in the streets the shouts of American voices —liberating American voices.

For these twenty thousand the war will not end—barring a miracle—next month or the month after that or even by next spring or summer.

It *will* end sooner, however, if not a single one of us lets down. If every one of us fights and works and invests in War Bonds right up to the last minute. It's the only way to speed victory.

How many extra Bonds are *you* buying?

6th War Loan

BUY MORE THAN BEFORE

THIS ADVERTISEMENT CONTRIBUTED BY ALCO PRODUCTS

TS DIVISION OF AMERICAN LOCOMOTIVE COMPANY

AFTER VICTORY—

Flying Horsepower

AT THE SIGN OF FRIENDLY SERVICE

SOCONY-VACUUM OIL COMPANY, INC.
26 Broadway, New York City

Mobilgas • Mobiloil Mobilubrication • Mobil Specialties

First in War, First in Peace—

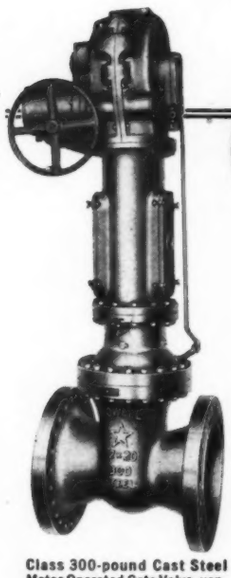
There's always a POWELL Valve for every requirement of Industry.

The "KNOW-HOW" acquired through 98 years of making valves—and valves only—has enabled POWELL Engineering to design valves to meet every problem of wartime flow control. This same "KNOW-HOW" is your assurance for the *post-war* future. Shown here are a few examples of a complete POWELL Line especially adapted to your industry. As new requirements arise, there'll be POWELL Valves to meet them.

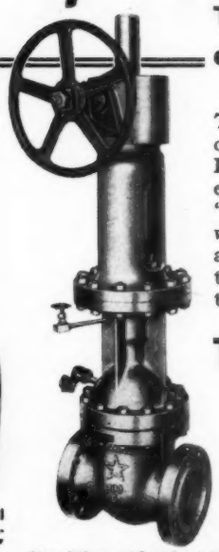
The Wm. Powell Company

Dependable Valves Since 1846

Cincinnati 22, Ohio



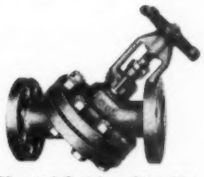
Class 300-pound Cast Steel Motor Operated Gate Valve, venturied from 12" port size to 20" size end flanges.



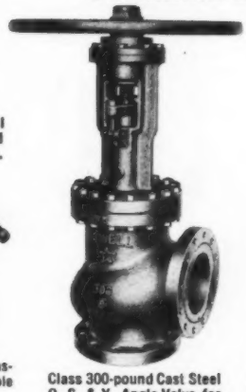
Class 300-pound Cast Steel, Bevel Gear Operated Gate Valve designed for ultra high temperature service.

Class 300-pound 16" Cast Steel Gate Valve with top-mounted electric motor operator.

Class 900-pound Cast Steel Swing Check Valve.

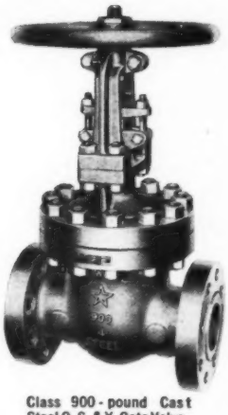


300-pound Stainless Alloy (Hastelloy) Separable Body Reversible Seat "Y" Valve.



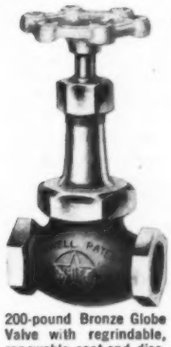
Class 300-pound Cast Steel O. S. & Y. Angle Valve for temperatures up to 1400F.

125-150-pound Iron Body Bronze Mounted or All Iron "Master Pilot" Gate Valve.



Class 900-pound Cast Steel O. S. & Y. Gate Valve.

150-pound Iron Body Bronze Mounted Globe Valve.



200-pound Bronze Globe Valve with regrindable, renewable seat and disc.

200-pound Bronze Gate Valve with renewable disc.

125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Gate Valve.

POWELL VALVES

It's Houdry and TCC that are setting the records!

First in Volume—Houdry and TCC units represent nearly two-thirds of the world's total* catalytic cracking capacity and have supplied all but a minor percentage of the United Nations entire war requirements of catalytic aviation fuel.

First in Quality—The highest-octane catalytic cracked aviation base stock being produced anywhere in the world in one pass comes from Houdry-licensed plants.

Houdry licensees will enter the post-war competition for motor fuel markets well armed. The proved efficiency of their processes is enhanced by the sustained engineering support of Houdry Laboratories, which make available improved operating techniques as well as pilot-plant evaluation of crude stocks to assure maximum yields.

** Includes capacity now serving the war program by improving aviation fuel quality through retreating.*

HOUDRY PROCESS CORPORATION
WILMINGTON, DELAWARE

Houdry Catalytic Processes and the TCC Process are available through the following licensing agents to all American refiners, subject to approval by the United States Government.

BECHTEL-McCONE CORP. Los Angeles, Calif.
THE LUMMUS COMPANY New York City, New York
E. B. BADGER & SONS CO. Boston, Massachusetts

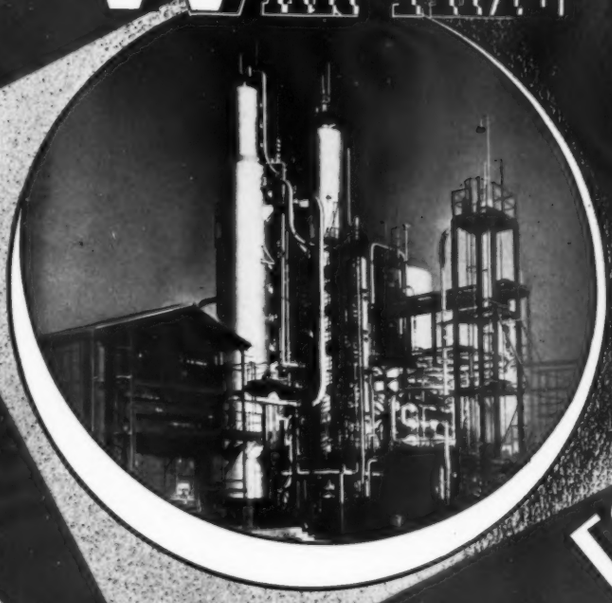
HOUDRY CATALYTIC PROCESSES ... FOR VICTORY IN WAR ... FOR PROGRESS IN PEACE

TCC

NAPHTHA

WAR TIME EXPERIENCE

POLYFORM



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FOR YOUR MOVE

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INTO PEACE-TIME PROFITS

M. E. K.

Available TO YOU—NOW!

Successful experience in every type of petroleum and chemical process plant design and construction.

The outstanding performance of Thermofor Catalytic Cracking . . . the war time process for peacetime profits . . . indicates its acceptance as the preferred post-war process for the economical production of high octane motor gasoline. The use of TCC synthetic bead catalyst improves the performance of TCC units beyond that of any other known catalytic operation.

In complete refinery operation, Naphtha Polyform . . . a process that raises the octane of heavy naphtha and utilizes refinery propanes and butanes for further enhancing the yields and octane level of motor gasoline — forms an excellent team with TCC for the production of premium motor gasoline.

For high yields of high viscosity index, low pour lubricating oils, Lummus offers, as in high octane motor gasoline, a wealth of experience in Propane Deasphalting, Vacuum Distillation, Furfural Refining, Benzol-Ketone Dewaxing and Clay Finishing. Lummus has built a large proportion of the world's solvent lubricating oil refining capacity — fourteen solvent refining plants . . . nineteen solvent dewaxing units . . . including complete lubricating oil refineries.

Lummus engineering service is always available for the study of specific problems, for the modernization of existing refineries and for future planning of all types of petroleum refining and petroleum chemical plants. For further information write to: THE LUMMUS COMPANY, 420 Lexington Avenue, New York 17 . . . 600 South Michigan Avenue, Chicago 5, Illinois . . . Mellie Esperson Building, Houston 2, Texas . . . 634 S. Spring Street, Los Angeles 14, California . . . 70 Barn Hill, Wembley Park, Middlesex, England.

LUMMUS

PETROLEUM REFINING PLANTS

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Clark "Angles" IN HELIUM PLANT

4,200 B. H. P. in Otis, Kansas, Installation

The superiority of CLARK "Angle" design has been proven in every field of compressor service. CLARK "Angles" handle all types of gas and are quickly adapted by our engineers to meet any special requirements.

Here CLARK "Angles" are shown in the Bureau of Mines helium plant at Otis, Kansas. Four of the seven 600 H.P. units perform dual service, one of the three cylinders on each engine being used for single-stage compression in one service, the other two cylinders for two-stage compression in a second service. The remainder of the seven units provide three-stage compression of nitrogen from atmospheric pressure to 600 pounds per square inch.

CLARK engineers are experts in solving special problems. Call on them.

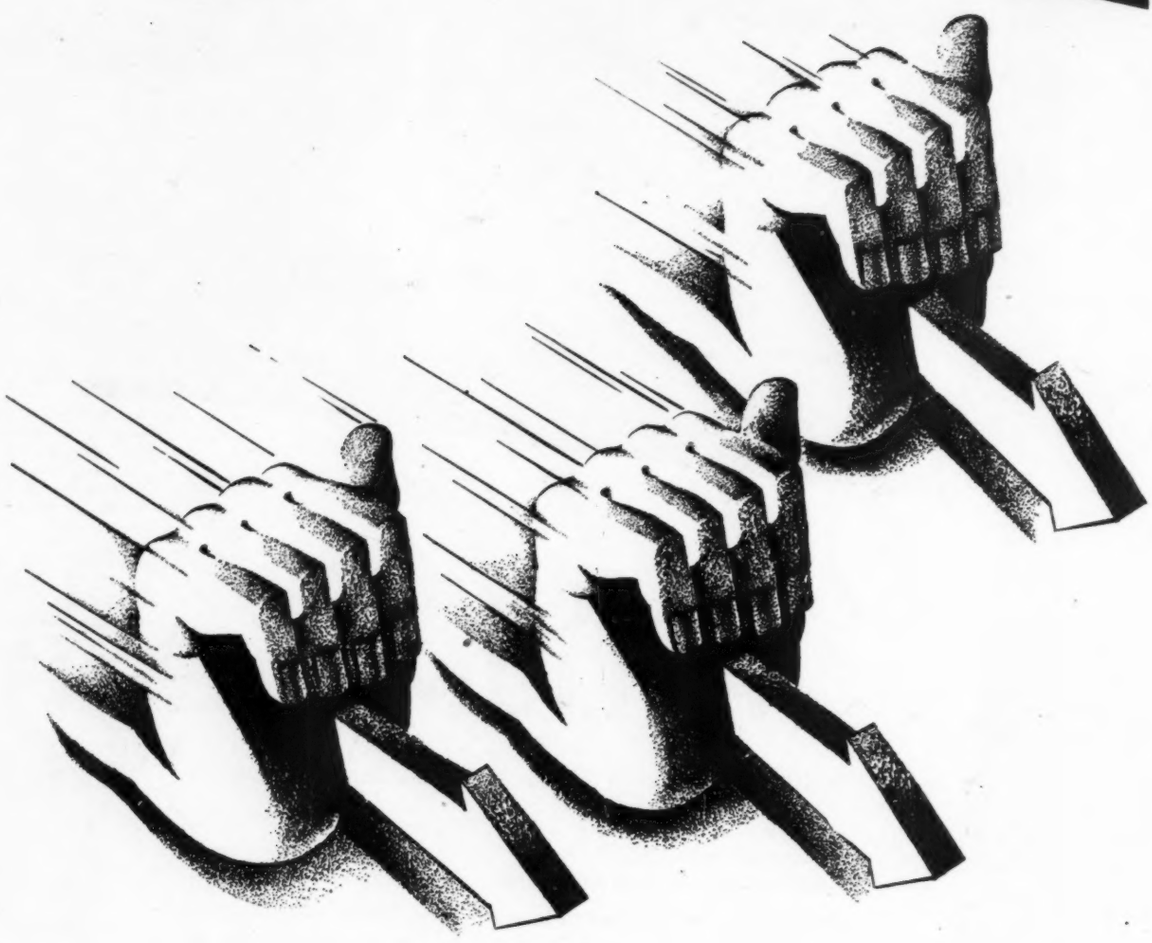
CLARK BROS. CO., INC. . . . OLEAN, NEW YORK

Export Office: 30 Rockefeller Plaza, New York. Domestic Sales Offices and Warehouses: Tulsa, Okla.; Houston, Tex.; Chicago, Ill. (122 S. Michigan Ave.); Boston, Mass. (Park Square Bldg.); Huntington Park, Calif. (5715 Bicket St.) Foreign Offices: London, England; Avda Roque Saenz Pena, 832 Buenos Aires.

CLARK

One of the Dresser Industries

THREE NEW PARTNERS . . . GOING



TERMINAL TOWER
CLEVELAND, OHIO

AHEAD WITH DRESSER

DRESSER INDUSTRIES now number ten.

Formerly, we were seven companies helping to bring basic services to the user more efficiently.

Our three new partners, each a specialist in its fields, both round out and broaden Dresser's scope of usefulness. This larger Dresser group can now serve industry and consumers with more products and greater experience.

The new Dresser members are bulwarked by an organization that assures their customers continued progress in product improvement, greater wherewithal for pioneering research and steady maintenance of service.

Dresser Industries, Inc., has progressed through the management principle of giving to alert, independent know-how an adequate backing and pooled resources. From these, each member draws teamed strength far greater than it could enjoy alone. The three new members of Dresser Industries, Inc., increase opportunities for mutual aid among the teammates, and at the same time, draw from the group advantages for those they serve.

MEMBER COMPANIES

Dresser Manufacturing Division
Bradford, Pa.

The Bryant Heater Co.
Cleveland, Ohio

Clark Bros. Co., Inc.
Olean, N. Y.

Pacific Pumps, Inc.
Huntington Park, Calif.

Bovaird & Seyfang Mfg. Co.
Bradford, Pa.

Dresser Mfg. Co., Ltd.
Toronto, Ont.

Van der Horst Corp. of America
Olean, N. Y. Cleveland, Ohio

PLUS

*International Derrick & Equipment Co.
Columbus and Marietta, Ohio
Torrance, Calif. Beaumont, Texas

*Roots-Connersville Blower Corp.
Connersville, Ind.

*Stacey Bros. Gas. Construction Co.
Cincinnati, Ohio

DRESSER Pipe couplings and repair devices for pipeline systems. Rings and forgings.

BRYANT Gas-fired boilers, winter air conditioners, furnaces, unit heaters and conversion burners for residential, commercial and industrial heating.

CLARK Engines and compressors for oil production and refining. Marine and stationary Diesel engines.

PACIFIC Hot-oil charging pumps; boiler-feed pumps; general-service pumps for the petroleum and other industries; oilwell plunger pumps; deep-well turbine pumps.

INTERNATIONAL DERRICK Oilwell pumping units, derricks and masts, drawworks, rotary tables and drilling units. Airport, communications and electric-power-line equipment and prefabricated steel buildings.

ROOTS-CONNERSVILLE Positive displacement and centrifugal blowers, exhausters, boosters and compressors. Air and liquid pumps and meters.

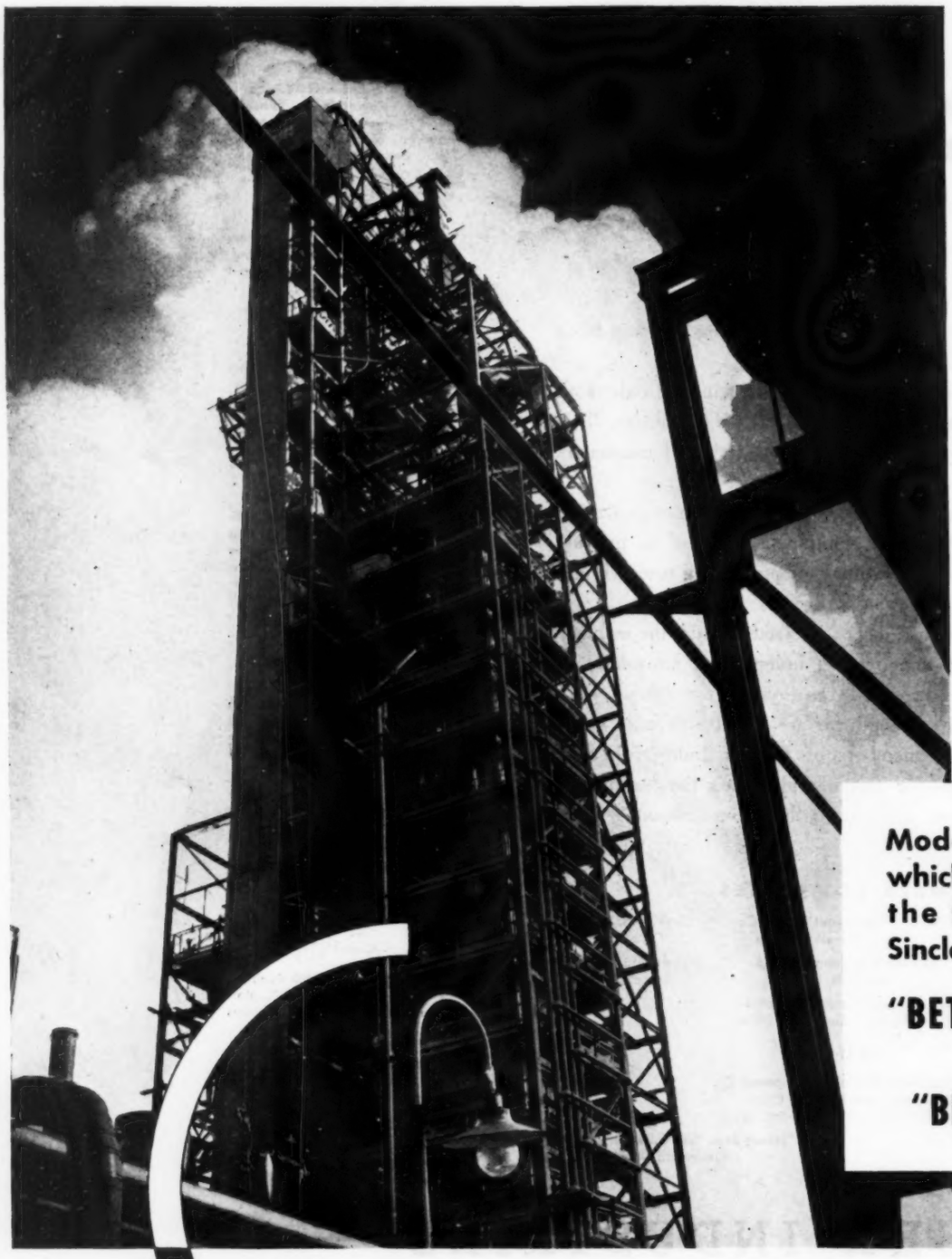
STACEY BROS. Storage holders, tanks and pressure vessels for the gas, oil, chemical and food industries.

BOVAIRD & SEYFANG Pumping engines, jacks, "powers", storage tanks and allied supplies and equipment for oilfields.

VAN DER HORST PORUS-KROME—a patented process of applying chromium lining on cylinder walls, piston rings and crankshafts—for longer wear.

—DRESSER INDUSTRIES—
INCORPORATED

NEW HEIGHTS IN REFINING...



Modern installations, of which this is typical, back the fulfillment of the Sinclair postwar program

"BETTER PRODUCTS"
and
"BETTER SERVICE"

SINCLAIR

25 YEARS
OF SUCCESSFUL
HEAT EXCHANGER
ENGINEERING &
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SINCE 1918
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ALTERNATORS AND GENERATORS

CONVERTING MACHINERY
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POWER FACTOR IMPROVEMENT PLANT

ELECTRIC WINDERS, ROLLING MILLS

ALL KINDS OF HEAVY ELECTRIC PLANT

MOTORS AND CONTROL GEAR
FOR ANY INDUSTRIAL APPLICATION
(large or small)

MAGNETOS, AND ELECTRICAL
EQUIPMENT FOR AIRCRAFT

REGENERATIVE DYNAMOMETER EQUIPMENTS
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(Road or Rail)

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MAZDA LAMPS, AND
MAZDALUX LIGHTING EQUIPMENT

ELECTRON VALVES
of every description

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SPECIFY BTH
ELECTRICAL EQUIPMENT

BTH

THE BRITISH THOMSON-HOUSTON CO., LTD.
CROWN HOUSE, ALDWYCH, LONDON, W.C.2.

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CONTROLLED QUALITY ASSURES

Ladish green-colored forged steel Long Welding Necks are produced with the same rigid metallurgical control of quality and identity that typifies all Ladish products.

Complete range of sizes in pressure ratings from 150 through 1500 p.s.i. in both carbon and alloy steels.

Steel identity stamped on each flange was pioneered by Ladish and has been a Ladish standard for many years

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ARMY E NAVY

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MORE pipe racking space because this new IDECO GIANT traveling BLOCK is the narrowest 350 TON BLOCK You can Buy.

ONLY 28¾" WIDE

Streamlined construction assures free movement past the drill pipe.

"Over-balanced" design permits greater lowering speeds.

Large (48 inch) alloy steel sheaves give you longest wire rope life.

Oversize alloy steel pin provides wide margin of safety.

Interchangeability of sheaves and bearings in companion crown and traveling blocks facilitates maintenance.

Buy this new Giant Traveling Block at Ideco stores or at your nearest Ideco sales office. It speeds your drilling and prolongs the life of your wire rope -- at no extra cost.

More new Ideco products coming ... Watch for them.

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Sales Offices - Eastern: Columbus 8, Ohio; Mid-Continent: Dallas 1, Texas; Pacific Coast: Los Angeles 13, California; Export: 122 East 42nd. St., New York 17, N. Y.; Sales Offices and Stores in All Active Oil Fields.

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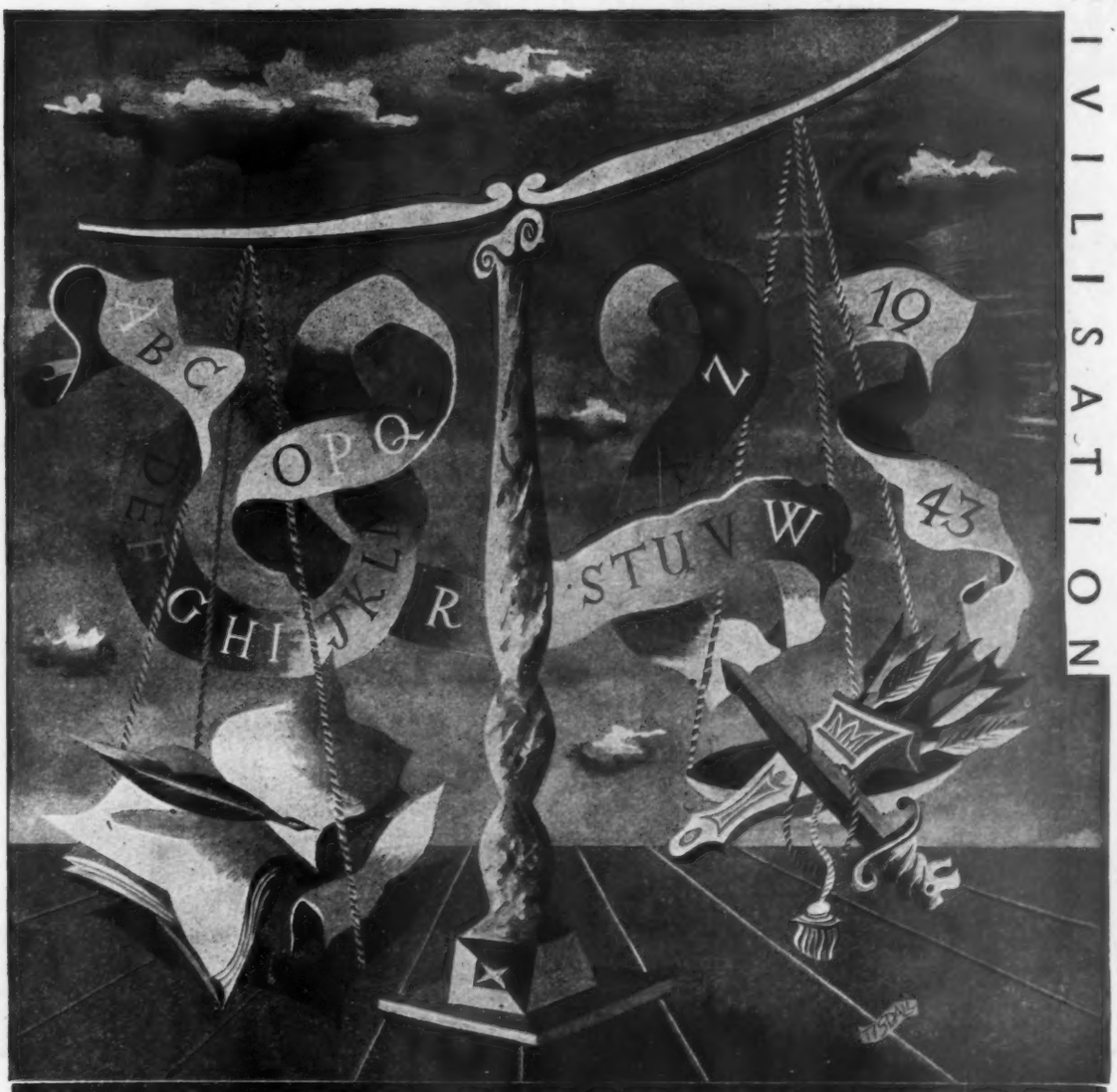
ONE OF THE DRESSER INDUSTRIES

FUNDAMENTALS OF CIVILISATION



No. 8 THE WRITTEN WORD

The monkish pen was mightier than the military sword; the one gave life to the spirit, the other only death to the body.

"With these twenty-six soldiers of lead I could conquer the world"—many a man of thought and will has brooded over this idea; and Napoleon came to say: "Three hostile news-sheets are more to be feared than a thousand bayonets."

The power of the pen has been multiplied till it becomes the power of the Press, that Archimedian lever which can influence the world of men. When the printing machines, with thunderous voice and lightning speed, multiply words – words – words, they tell a million men at dawn what only one man knew at midnight.

Behind the power of the Press is the strength of Steel.

THE UNITED STEEL COMPANIES LTD

THE UNITED STEEL COMPANIES LIMITED

STEEL, PEECH & TOZER, SHEFFIELD
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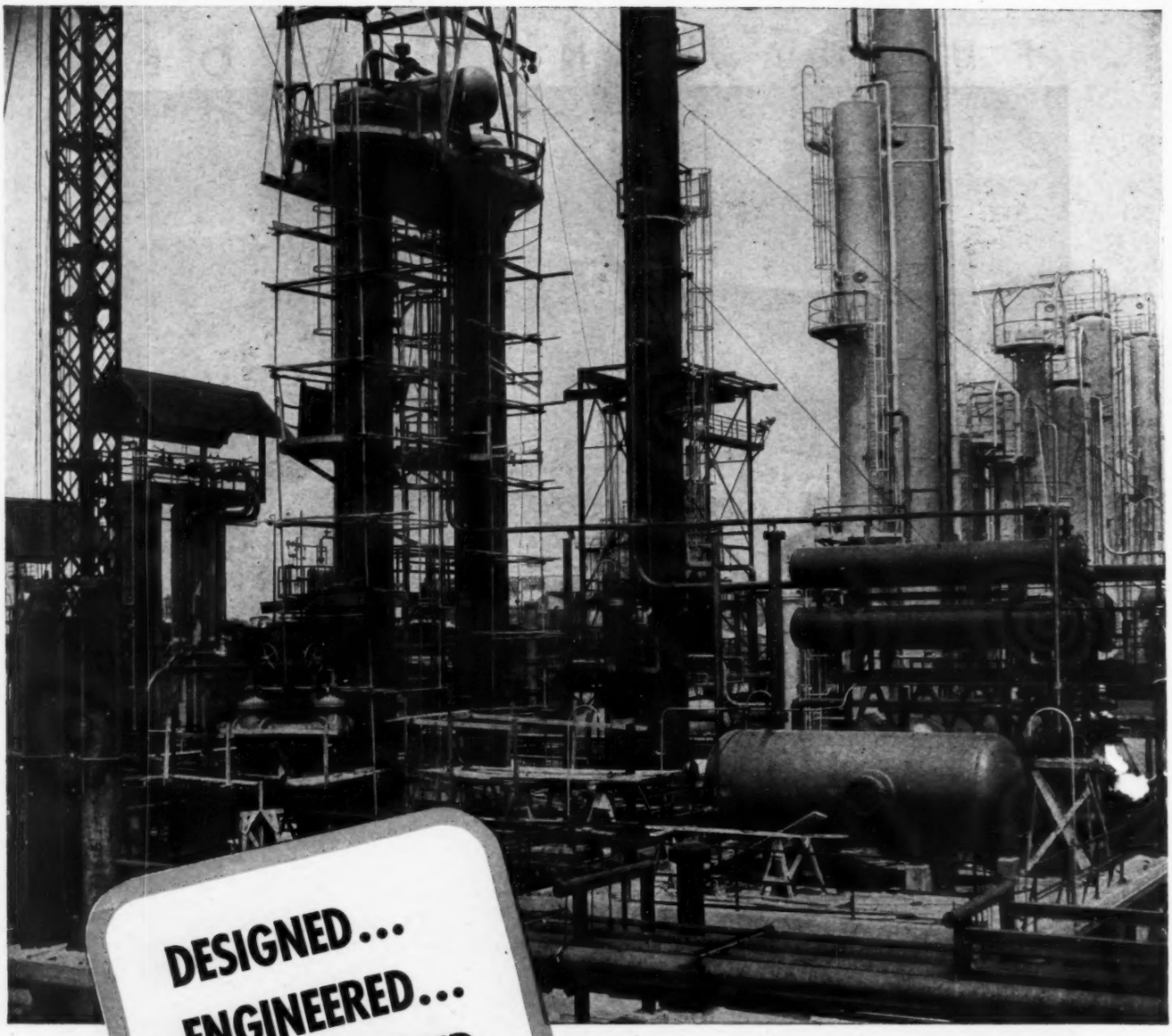

DESIGNED... ENGINEERED... CONSTRUCTED BY McKEE

● The photo above shows a new Aviation Gasoline plant under construction. This is one of many modern plants for scientific refining processes desig. d, engineered and constructed by Arthur G. McKee & Company.

Arthur G. McKee & Company

★ *Engineers and Contractors* ★

2300 CHESTER AVENUE • CLEVELAND, OHIO

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BRITISH WAR PRODUCTION

is undoubtedly being greatly assisted by PNEUMATIC PLANT and the AIR COMPRESSOR illustrated is one of the many HOLMAN MODELS supplying the air

"TM60S" TWO-STAGE COMPRESSOR F.A.D.— 516 c. ft./m. to 100 lb./sq. in. at 750 r.p.m.

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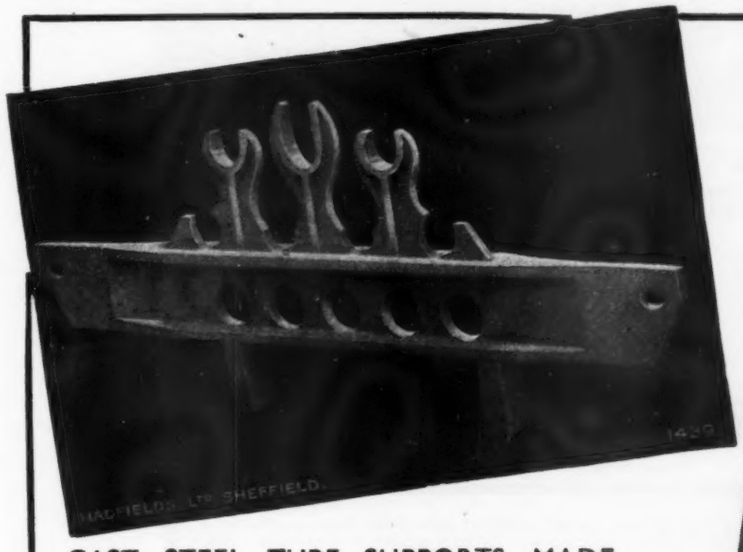
BROS. LTD.

Holman

PHONE: CAMBORNE 2275

CAMBORNE - - - ENGLAND

GRAMS: AIRDRILL, CAMBORNE



CAST STEEL TUBE SUPPORTS MADE IN "ERA H.R." HEAT-RESISTING STEEL FOR THE DOWNDRIFT EQUIFLUX RESIDUUM HEATER OF A LARGE OIL PLANT

HIGH QUALITY STEELS FOR THE OIL INDUSTRY.

TRADE ERA MARK H.R.

HEAT-RESISTING STEELS HAVE NUMEROUS APPLICATIONS. For parts of plant requiring rigidity and low scaling loss at high temperatures they are unequalled.

TRADE ERA MARK C.R.

NON-CORRODING STEELS FOR THERMOWELLS, REACTION VESSELS, PUMP PARTS, BUBBLE CAPS. Highly resistant to the attack of numerous chemical agents.

HADFIELDS LTD.

EAST HECLA WORKS • SHEFFIELD • ENGLAND.

No. 7232

FACTS... About Postwar Refinery Economics

IT IS NOW virtually certain that immediately after the war competition will be severe. Consumers will demand improved quality in petroleum products. To meet all these overall market characteristics, M. W. Kellogg has already undertaken projects for the modernization of existing refineries to achieve specific objectives.

1. *With manufacturing costs lower than those for his prewar gasoline,* one Kellogg customer will increase his gasoline to 80-85 octane with less than 1 c.c. of lead.

2. Another Kellogg customer, whose distillates already meet postwar quality requirements, will produce 20% more of these profitable products—20% less of unprofitable residual oils—*with no increase in the total refining cost of finished products.*

THESE specific objectives of our customers are not inspired by the realm of theory. The process concepts to achieve them are commercially practical—proven in the Kellogg "pilot" refinery and now being finally engineered. Such projects, already under way, are a measure of the competitive "plus" that an M. W. Kellogg job can give to *any* refiner... regardless of the size of his operation.

THE M. W. KELLOGG COMPANY

★ Only Kellogg Service Has Them All

★ **LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

★ **24-HOUR-A-DAY PILOT PLANTS**—17 refining processes operating continuously—providing accurate data for commercial scale application.

★ **EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled... embracing both pilot plant runs and the operation of Kellogg-built refineries. Data extends from beginning of modern refining.

★ **PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development, for more than 20 years... currently exemplified by their work on fluid catalytic-cracking.

★ **MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

★ **METALLURGICAL LABORATORY**—Establishes continuous check of specifications...creates new techniques for the fabrication of refining equipment.

★ **PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries... team-experience cuts costs, speeds construction.

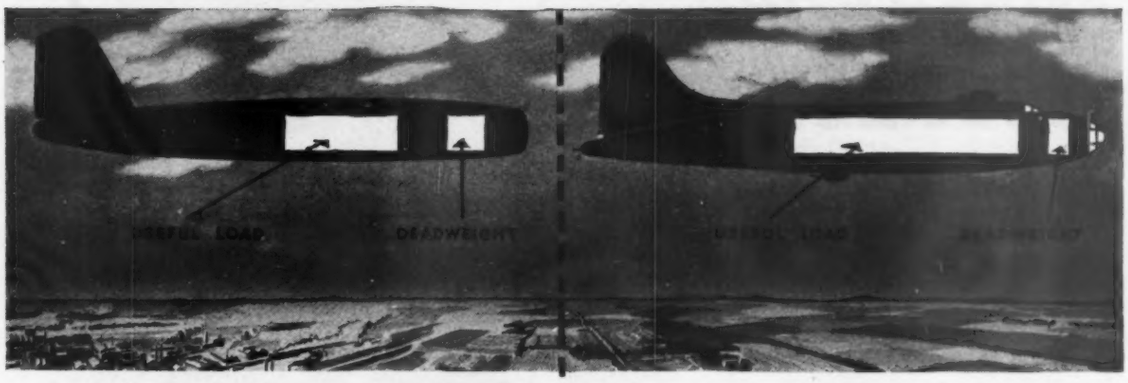
★ **OPERATING STAFFS**—Specialists at placing new units "on stream"... training of refiner's own operating crews.

★ **LICENSING SERVICE**—Licenses available through Kellogg as Licensor or licensing agent for all types of refining processes.

KELLOGG

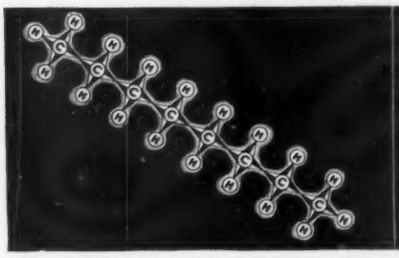
225 Broadway, New York 7, N. Y. • Jersey City, N. J. • 809 Grand Ave., Los Angeles, Calif. • Philtower Bldg., Tulsa, Okla. • 402 Esperson Building, Houston 2, Texas • Stone House, Bishopsgate, London, EC2

DIAGRAM FOR VICTORY

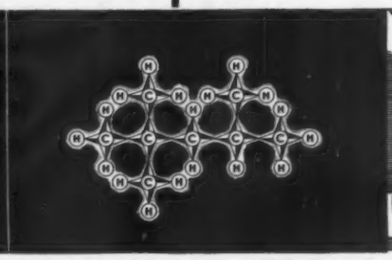


1934 **This represents the ratio of Useful Load to Deadweight** in a bomber of the early 30's. Then, in 1934, a powerful ally—a new fuel—came to the aid of Useful Load, and dealt the knockout to Deadweight. Shell Research supplied "the makin's" of the first 100 octane aviation fuel ever produced in a commercial quantity.

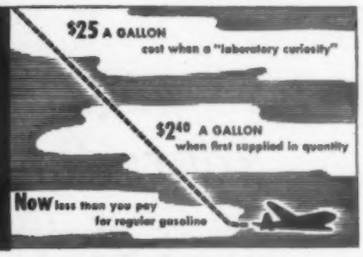
1944 **And this, representing today's ratio of Useful Load to Deadweight,** is America's Diagram for Victory. Freed from the limitations of less productive fuel-weight and engine-weight, designers have produced bombers and fighters whose flying range, speed, and "ceiling" make it possible to carry the war to the Enemy.



The Chemist uses symbols meaningless to the average man. To a chemist, the mixture of hydrocarbons in regular automobile gasoline might look like the above.



But when Iso-octane was discovered—a new, rare combination of the atoms found in petroleum—in the symbolic language of the chemist it had this much more elaborate form.


$25 A GALLON
cost when a "laboratory curiosity"
$2.40 A GALLON
when first supplied in quantity
NOW less than you pay
for regular gasoline

The first "laboratory" cost of Iso-octane was about $25 per gal. Then in 1934—Shell was able to supply 1000 gallons of Iso-octane—to make 100 octane Aviation Fuel—at $2.40 per gal.

This year marks the close of an historic Decade in the Age of Flight.

It began when the U. S. Army Air Corps was provided with 1000 gallons of Iso-octane, to make the first commercial supply of 100 octane aviation fuel.

You can judge the importance of that event in 1934 by our present fighting advantages which grew from it.

Even at the 1934 price of $2.40 a gallon, the Army got excellent value, for Shell scientists responded to the Government's request for 95 octane with a fuel 5 octane points better than hoped for—establishing the 100 octane standard which endures today.

But at $2.40 a gallon, even our rich country could scarcely sustain the burden of the present monthly output of over 630,000,000 gallons of this fuel.

In the years of urgent need—the free American oil industry, working as a team, is making what captive Enemy Industry can't make.

Shell is proud to be part of the American team which is producing over 20 millions of gallons of 100 octane aviation fuel, every day.

At present, Shell alone is producing enough 100 octane, daily, to fuel a bomber mission of 2,400 planes from England over Germany.

A Forward-Looking Company Serves the Public in All Four Ways

1. **The Consumer**—through fair prices, good service, and the development of new and better products.
2. **The Community**—through actions that promote local and national welfare in peace or war.
3. **Its Employees**—through job security, fair wages and opportunity to advance.
4. **Its Shareholders**—through a fair return on their investment.

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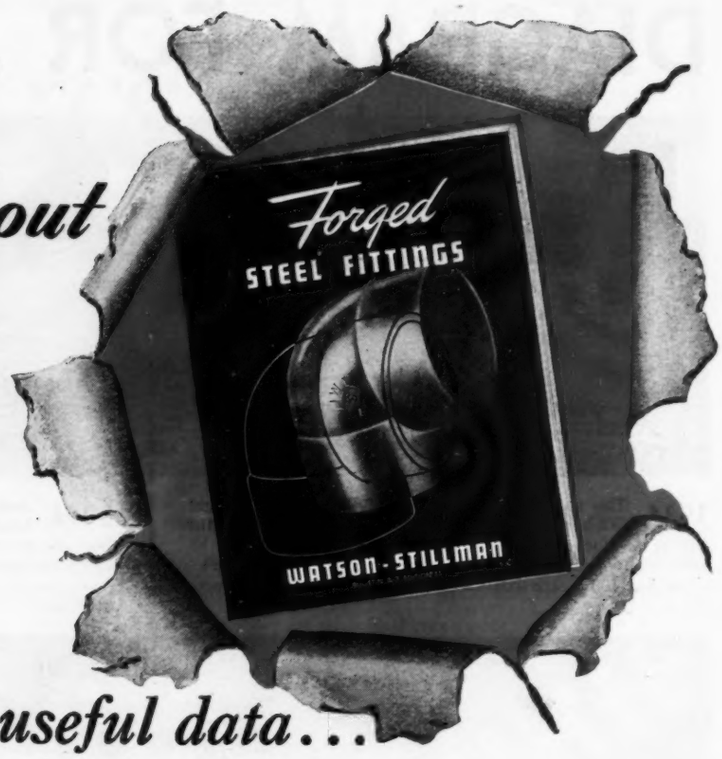
SHELL OIL COMPANY, Inc.

FACTS *and* FIGURES *about* FITTINGS



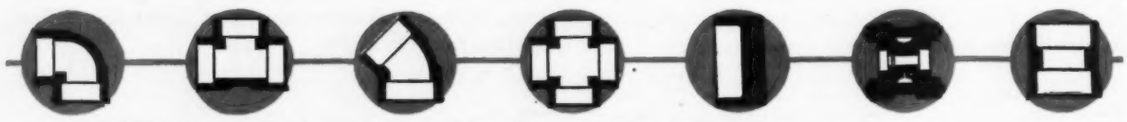
48 pages of useful data... yours for the asking!

Information wanted on pipe fittings? Watson-Stillman has the answer in Catalog A-3, which gives you more than 40 pages of factual data on FORGED STEEL SCREWED END AND SOCKET WELDING FITTINGS. Includes photographs... diagrammatic drawings... pressure ratings... dimension tables ... excerpts from piping codes ... engineering tables ... stress calculations... specifications... pressure and temperature charts ... pipe thread dimension tables ... fillet weld calculating data ... steel pipe data.

The Watson-Stillman line includes all types of fittings for standard, extra-heavy and double extra-heavy pipe lines for high pressure, high temperature service in refineries, oil fields, chemical plants, ship construction, air conditioning and refrigeration, power plants and hydraulic installations. They assure low material and maintenance cost. The Double Diamond trademark is your guarantee. The Watson-Stillman Co., Roselle, N. J.

MORE FACTS... MORE FIGURES

To round out Watson-Stillman service four additional booklets are also available—full of factual data on Valves, Pumps, Jacks and Wire Rope Shears, four groups of products for use on construction and maintenance jobs; in oil fields and chemical plants; in arsenals and shipyards. Send for any one *or* all *of these booklets.*



WATSON-STILLMAN

Distributor Products Division

Engineers and Manufacturers of Forged Steel Fittings, Valves, Wire Rope Shears, Pumps, Jacks, and Hydraulic Machinery and Equipment.

FITTINGS • VALVES • WIRE ROPE SHEARS • PUMPS • JACKS • ***Sold Through Leading Distributors***

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